JAN 27 1917

Engineering News

Volume 77, No. 4
Issued Every Thursday
Hill Publishing Company

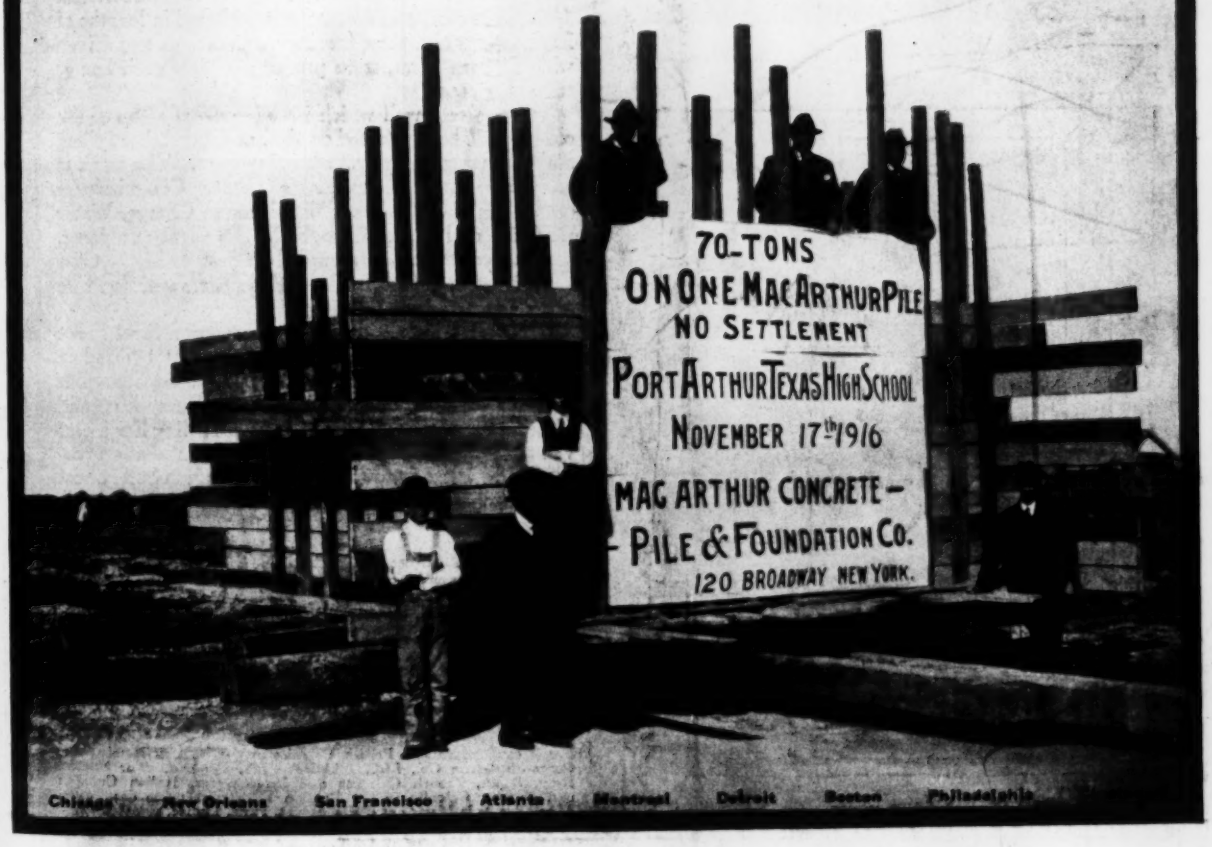
NEW YORK, JANUARY 25, 1917

Price, 15 Cents
Contents, First Page
Advertising Index, Last Page

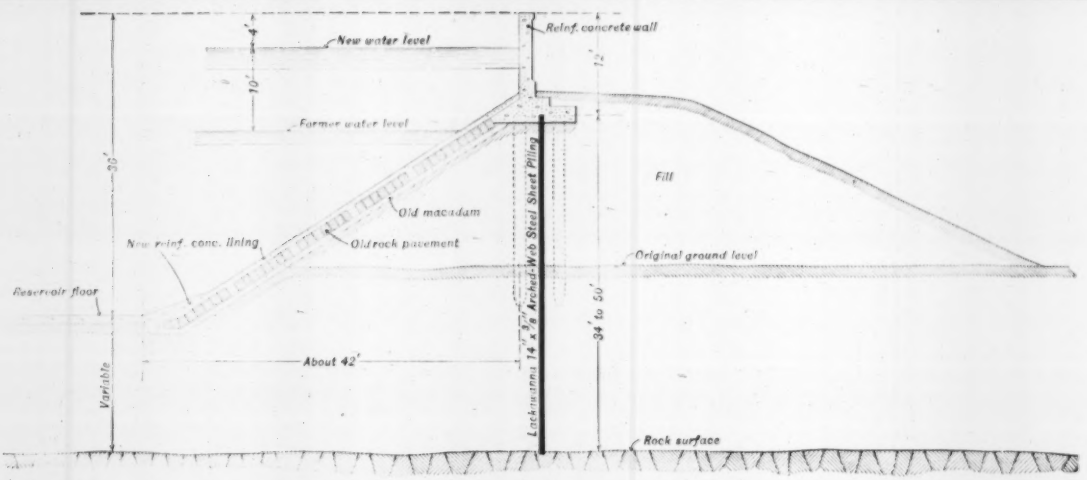
PROOF OF "*SUPERSTRENGTH*"!

70 TONS ON ONE PEDESTAL PILE

Write for Handbook N



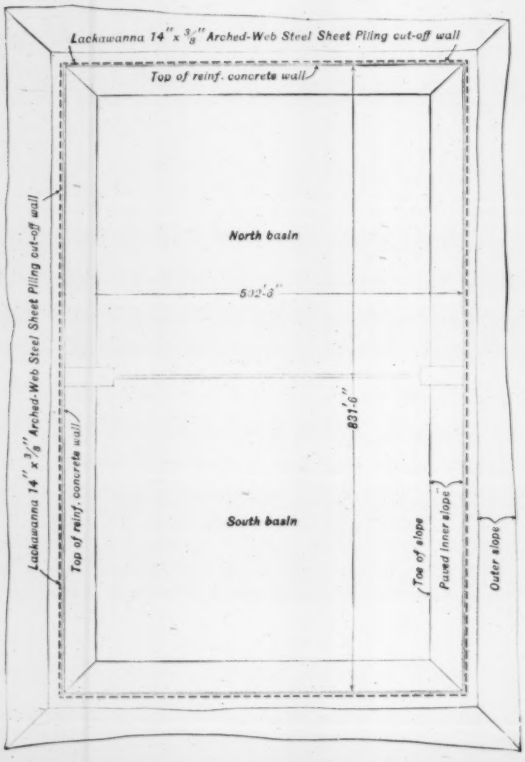
Chicago New Orleans San Francisco Atlanta Montreal Detroit Boston Philadelphia



2,000 Tons of Lackawanna Steel Sheet Piling Being Used in the Reconstruction of Compton Hill Reservoir, St. Louis

To check a leakage of almost a million gallons a day from the 65,000,000-gallon Compton Hill Reservoir, St. Louis, Mo., a new lining is being built and a continuous wall of Lackawanna Steel Sheet Piling driven through the bank from top to rock.

An upward extension of concrete is being placed to raise the wall 10 feet and so increase the storage capacity to about 95,000,000 gallons. The old division wall is also being replaced by one of more substantial strength to meet the raise in water level. The reservoir could not be kept out of service long, so the plan adopted was to reconstruct the division wall first.


Lackawanna 14" x 3/8" Arched-Web Steel Sheet Piling cut-off wall
Top of reinf. concrete wall
Lackawanna 14" x 3/8" Arched-Web Steel Sheet Piling cut-off wall
Top of reinf. concrete wall
North basin
532'-3"
831'-6"
South basin
Toe of slope
Paved inner slope
Outer slope

Borings indicated that the bed rock was at *maximum and minimum* depths of 53 and 36 feet, the depth being mainly about 40 to 45 feet. The Lackawanna Arched-Web Sheet Piling was therefore purchased in lengths of 35 to 50 feet and these marked for locations and driven with a steam hammer to produce a fairly even line of the piling tops.

The concrete wall which is to be built on top of the old wall will be supported on the line of steel sheet piling and two rows of concrete bearing piles. The work is under direction of Edw. E. Hall, Water Commissioner of St. Louis. C. C. Black, Engineer in Charge, Water Division, and F. R. Wiederholdt, Resident Engineer, and the contract was awarded to Hiram Lloyd Construction Co. of St. Louis. More particulars will be given in our advertisement next week.

Permanent installations of Lackawanna Steel Sheet Piling in connection with concrete can be utilized in cutoff walls, docks, shore revetments, dams, etc., with every assurance of watertightness, durability and pleasing appearance. Our Steel Sheet Piling Engineers will aid in perfecting plans and making installation economical. Write for our book "Lackawanna Steel Sheet Piling."

Lackawanna Steel Company

General Sales Office and Works, Lackawanna, N. Y.

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Engineering News

VOLUME 77 · JANUARY 25, 1917 · NUMBER 4

Huge Chicago Freight Station for Pennsylvania Lines

The extensive railway-terminal improvements at Chicago in connection with the construction of the new Union Station include a very large combined freight station and warehouse for the Pennsylvania Lines.

To make way for the development of the passenger station it was necessary to abandon certain freighthouses of the P., Ft. W. & C. Ry., and in planning the new freight terminal it was arranged to concentrate all the downtown less-than-carload business of this road in one large freight station. The building is about 750x420 ft. in plan, extending between Polk and Taylor St. and lying between the main tracks and the river.

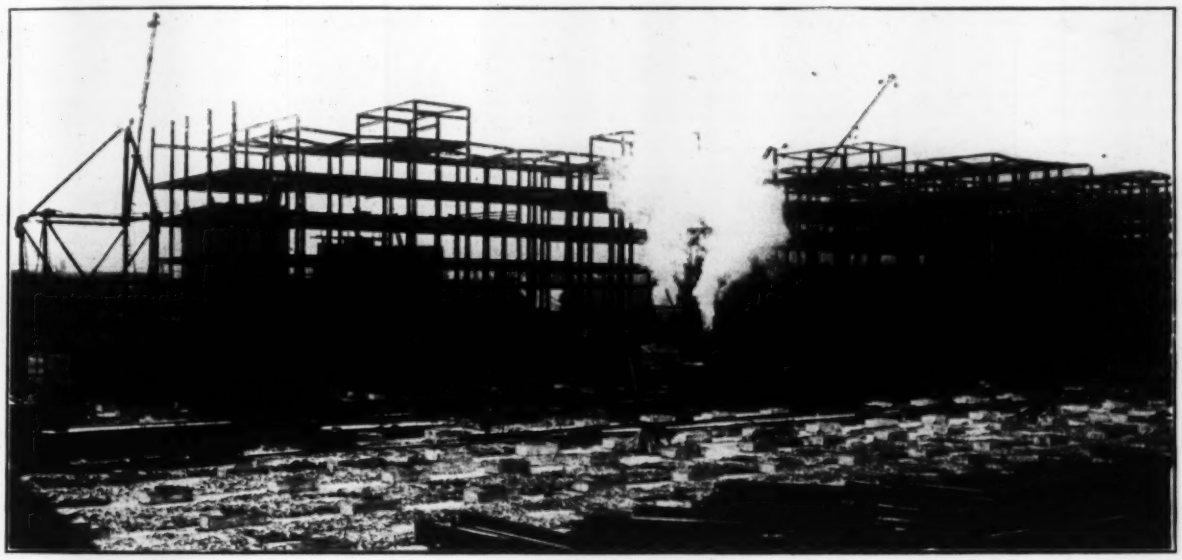


FIG. 1. ERECTION OF THE STEEL FRAMING FOR THE CHICAGO FREIGHT TERMINAL OF THE PENNSYLVANIA SYSTEM

There will be 17,000 tons of structural steel

On account of the extremely high cost of property in this vicinity and the desirability of utilizing the available space to the best advantage it was decided to build a two-level freighthouse with three upper floors for warehouse and storage purposes. South of the station will be large team yards, with 50-ft. roadways of 2.3% grade to connect the yard driveways with Taylor St. The plans at track level and street level are shown in Fig. 2, while Fig. 3 shows the general design and arrangement of the building.

The railway tracks are in the basement, at main-track level, while one of the outside tracks passes under a corner of the building. There will be 19 stub tracks in the building, arranged singly and separated by trucking platforms 5½ to 27 ft. wide. The ten tracks (with nine platforms) on the east side are for outbound business and have capacity for 199 cars. The nine tracks (and nine platforms) on the west side are for inbound business and have capacity for 176 cars. These tracks converge in groups, which again converge into a three-track approach. In this fan-shaped approach layout No. 8 frogs and 13° curves are used.

On either side of this approach will be a team yard with stub tracks in pairs, separated by driveways. The yard on the east (outbound) side will have capacity for 206 cars, while that on the west (inbound) side will have capacity for 197 cars. South of the approach will be storage tracks having a total capacity for 117 cars.

The first floor (for teams), or main freighthouse floor, will be at the street level, the streets being carried across the tracks by viaducts. At its east side will be the outbound house, 100 ft. wide, and on the west side the inbound house, 170 ft. wide. These are separated by a 76-ft. space divided into two 38-ft. driveways. On the outer side of each house also is a 38-ft. driveway. All these driveways are covered throughout their entire length.

Above this main freighthouse floor the building is carried up for three stories over the inbound and outbound houses and central driveway. This area is 745x343-ft. Six light courts 40x153½ ft. are located over a portion

of the inbound house and central driveway. The general freight offices will occupy the north (Polk St.) end of the second floor. At this end also will be a tower 50 ft. square and 180 ft. high above the street level, with a 16-ft. clock face on each side of the tower.

At the north end of the outbound house will be a sub-basement about 66x72 ft. to accommodate the heating plant and other mechanical apparatus. At one side of this will be a coal bin and ash bin, crossed by a track for cars. This sub-basement will have heavy retaining walls and a reinforced-concrete floor about 5 ft. thick. It will be covered at the track-floor level by a framing of I-beams embedded in a concrete slab.

An extensive equipment of electric freight elevators will serve the several floors and platforms. There will also

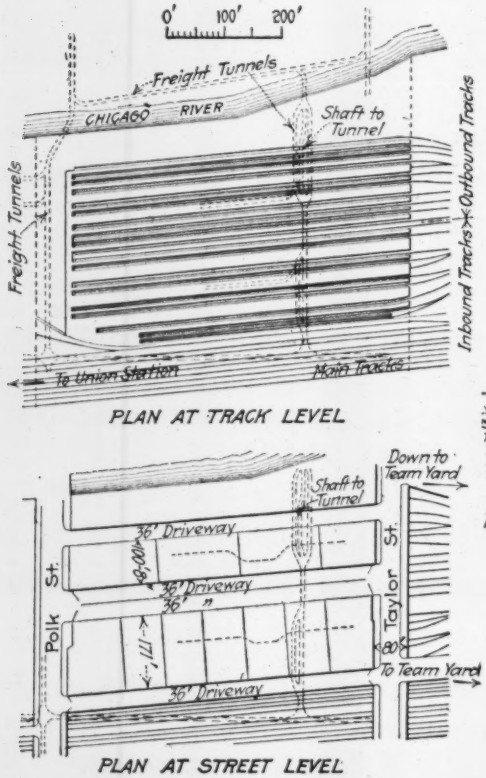


FIG. 2. PLAN OF PENNSYLVANIA FREIGHT TERMINAL

be two elevators connecting (through oval shafts) with the Chicago Tunnel Co.'s narrow-gage electric freight-railway system, the tunnels of which pass under the station. These elevators will be large enough to carry the tunnel cars. The total equipment, exclusive of the tunnel elevators, will comprise 50 elevators, and 32 of these will form the first installation.

Structural Design of Building

The building is of steel-frame construction with reinforced-concrete floors and roof, and brick curtain walls. All the steelwork is incased in concrete fireproofing, the concrete being secured by wire netting wrapped around the steel. On the columns the minimum thickness of concrete is 3 in. There are about 17,000 tons of structural steel in the building.

The columns are of H-section, built up of side and web plates with four interior angles. The typical floor framing is shown in Fig. 4. On the first floor the main framing in the freighthouse portions consists of transverse 24- to 30-in. plate girders and 24-in. I-beams, and longitudinal lines of 24-in. I-beams. The central and side driveways are carried by transverse 19½-in. and 34-in. plate girders spaced about 7 ft. apart. The upper floors have generally similar framing, except that there are no driveways to be carried and 24-in. I-beams are used mainly, both in the wings and the transverse portions. Girders are placed where the intermediate columns of the upper floors have to be supported above the central driveways.

At the second-floor level are the roofs over the side driveways, carried by transverse 18-in. girders and I-beams spaced 7 ft. apart. At the same level are the roofs in the light courts, over the freighthouse floor. They have high triangular skylights, partly in one span and partly in two spans. Inclined skylights are placed along the corner between the driveway roof and building, and saw-tooth skylights are used in some places. The skylight sash is all hinged at the upper edge, to provide for ventilation.

The floor bays are of various sizes, from 14x20 and 14x25 ft. to 20x20 and 20x25 ft. The first, or main

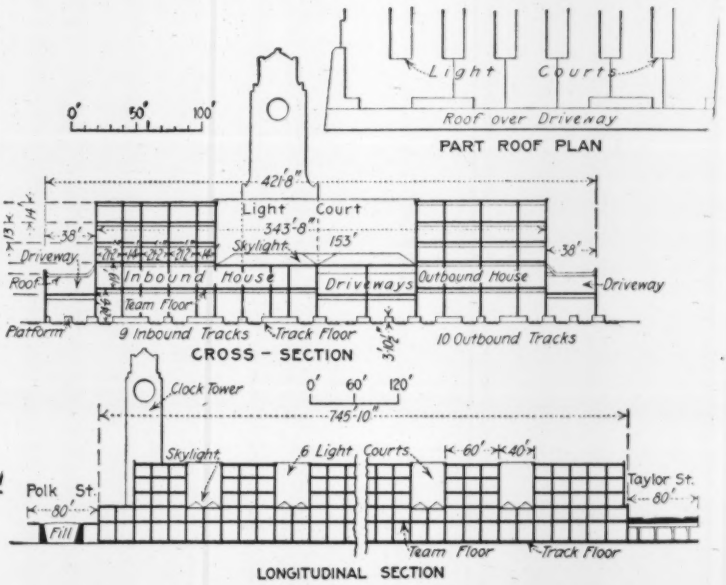
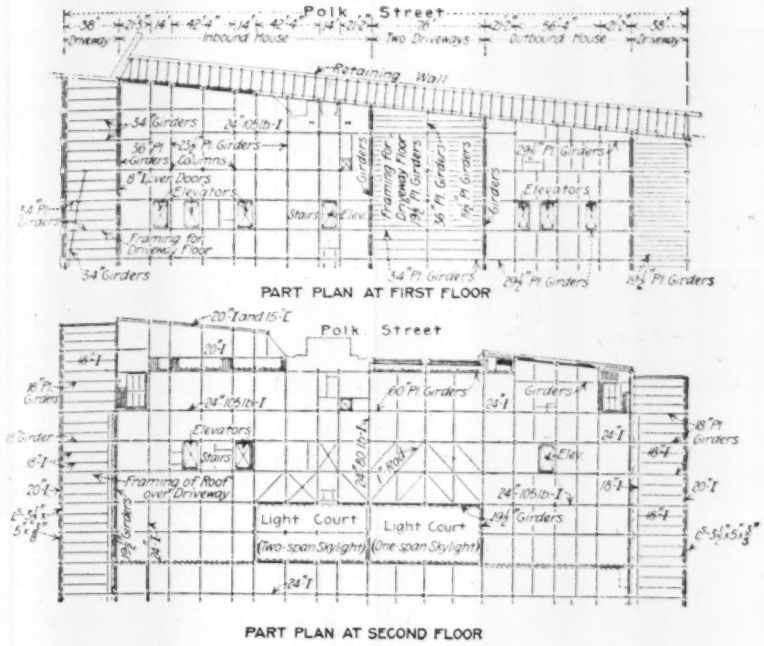


FIG. 3. SECTIONAL ELEVATIONS OF PENNSYLVANIA TERMINAL

freighthouse, floor has a concrete slab 8 to 11 in. thick (in different bays), including a 1½-in. mastic finishing coat. In the three warehouse floors the concrete slab is 8¾ to 10 in. thick, with a 1-in. special cement finish. The main roof slab is 5½ to 6 in. thick, while the roofs over the outside driveways have a 3½-in. slab. Each floor bay has rectangular reinforcement with diagonal lines of bars between the corners, as shown in Fig. 6.

The floor loads are as follows: First floor (freighthouse), 300 lb. per sq.ft.; second floor (warehouse), 250 lb.; third and fourth floors (warehouse), 200 lb.; tower floor (offices), 125 lb.; roof, 30 lb. The driveways are designed to carry 24-ton motor trucks.

The column shoes are seated on I-beam grillages in rectangular concrete pedestals. Some of these pedestals carry individual columns and have their own footings. Others are carried on long footing walls. The arrangement of the footings is irregular, in order to suit the column spacing and to provide for openings, etc. In the east



PART PLAN AT FIRST FLOOR

PART PLAN AT SECOND FLOOR

FIG. 4. STEEL FRAMING PLANS OF FREIGHT TERMINAL

portion of the building the footing walls run in a longitudinal direction, while in the west portion they run transversely.

The footing walls are 11½ to 17½ ft. wide on the base, and 6 ft. deep. Their sides are vertical for about 3 ft. from the base and then slope inward toward the top. They are reinforced with steel bars. Typical details of the foundations are shown in Fig. 6, and a view under construction in Fig. 5.

All the footings are carried on 40-ft. timber piles driven into the stiff, blue, Chicago clay. The length of the piles was limited by the fact that several of the tunnels of the Chicago Tunnel Co. pass under the site, as noted above. The piles were not pointed or shod. They were driven by steam hammers. In order to determine the settlement, test piles were driven, and each was loaded with 40 tons of pig iron. The total settlement in 11 days was 0.034 in. to 0.067 in., and after that time there was no further movement. The foundation concreting over the entire area was done by spouting from the towers of two stationary concrete-mixing plants. Materials were delivered on cars and elevated to storage bins over the mixers. The cement was handled in bulk. From the box-cars it was shoveled into the hopper of a screw conveyor, which delivered it to an elevating conveyor discharging into the bin. The sand and stone were placed in the bins by means of electrically operated derricks. From the bins the materials were delivered to a measuring hopper divided into three compartments for automatically separating the proportions. The concrete is a 1 : 2 : 4 mix.

From the mixer the concrete was discharged into the bucket of an elevator tower and then dumped into a hopper at the head of the spouting. From the main tower, lines of rigid trussed spouting extended about 50 ft. to secondary towers, beyond which were lines of flexible spouting supported partly by cables from these towers and partly by timber frames and horses.

The erection of the steelwork was done by means of large tower derricks traveling on tracks on the ground

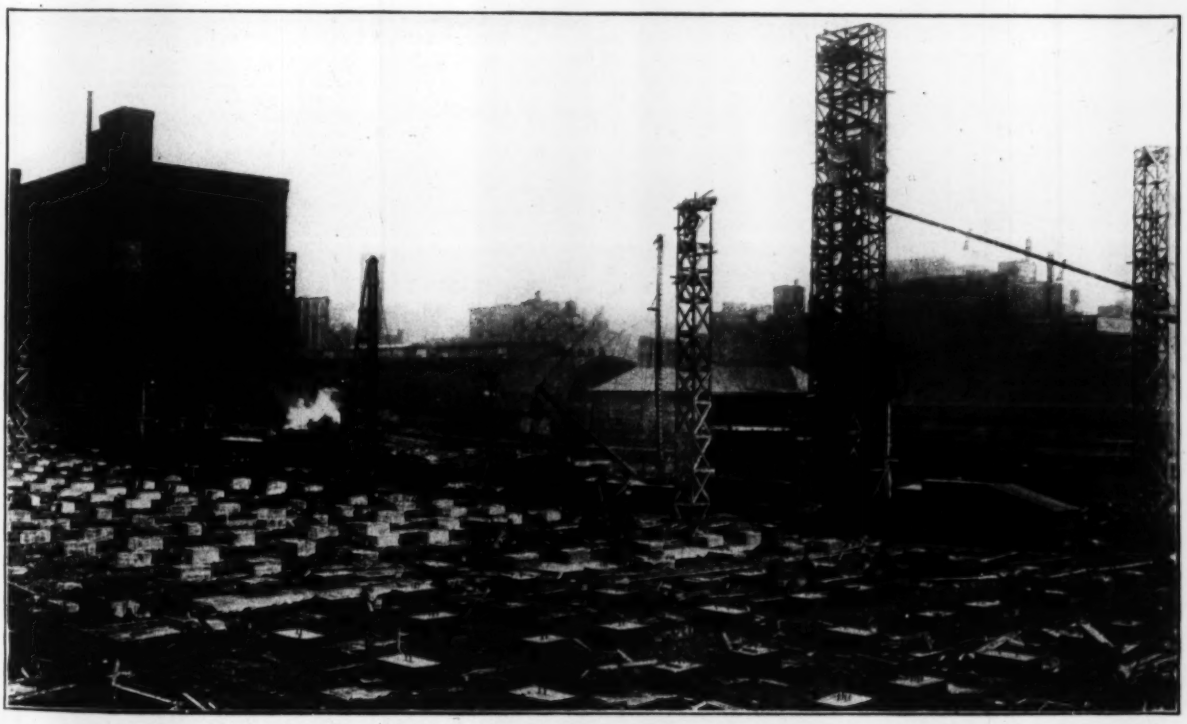


FIG. 5. CONSTRUCTION OF THE CONCRETE FOUNDATIONS FOR THE CHICAGO FREIGHT TERMINAL OF THE PENNSYLVANIA SYSTEM

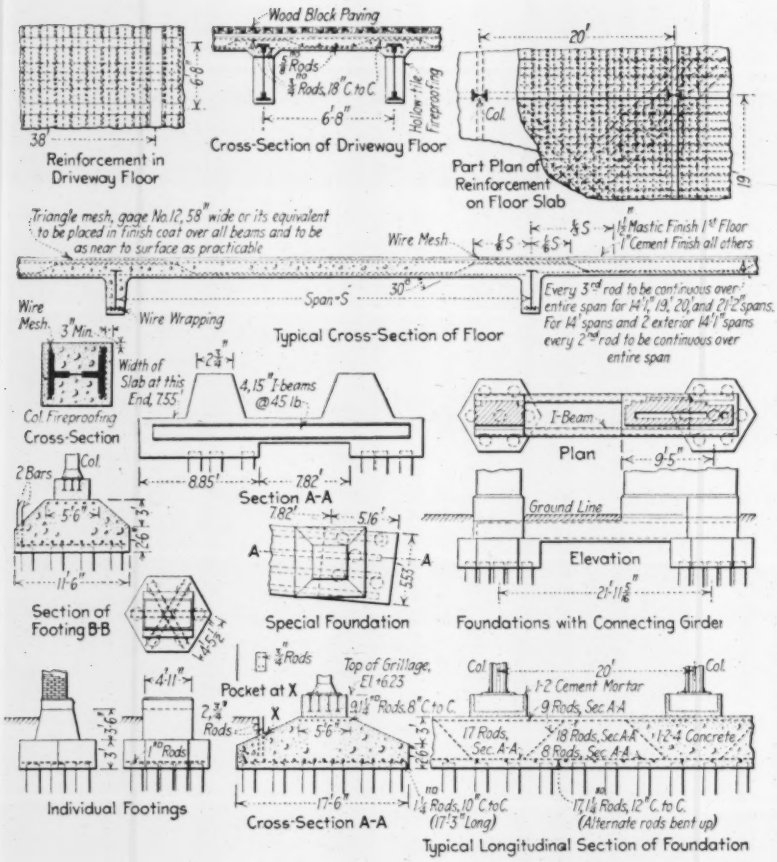

Wood Block Paving
Reinforcement in Driveway Floor
Cross-Section of Driveway Floor
Part Plan of Reinforcement on Floor Slab
Typical Cross-Section of Floor
Every 3rd rod to be continuous over entire span for 14', 18', 20', and 21'-2" spans. For 14' spans and 2 exterior 14'-1" spans every 2nd rod to be continuous over entire span
Cross-Section
Section A-A
Plan
Elevation
Section of Footing B-B
Special Foundation
Foundations with Connecting Girder
Individual Footings
Cross-Section A-A
Typical Longitudinal Section of Foundation

FIG. 6. DETAILS OF FOUNDATIONS AND FLOORS OF FREIGHT TERMINAL

level. Each had a rectangular timber tower surmounted by a stiff-leg derrick, the boom being thus at sufficient height for placing the roof framing. These derricks were described in *Engineering News*, Oct. 26. The steel was unloaded from cars and stacked and re-handled on the site by a steam-derrick car. The framing for the west half of the building was erected first, and Fig. 1 shows this part of the structure almost completed. As a protection for the workmen, each floor had a temporary plank decking, as required under the Illinois law providing for safety methods in construction work. As the height from the ground to the second floor was 43 ft., all floors had to be decked; but where the height does not exceed 32 ft., the law permits the decking to begin at the second floor. The steel erection of the portion of the structure as shown in Fig. 1 was practically completed and ready for concreting in June, 1916, but work was stopped by a general strike.

Contractors and Engineers

The Blome-Sinek Co., of Chicago had the contract for the foundation piling and concrete substructure. The Thompson-Starrett Co. had the contract for the structural steel, which was fabricated by the McClintic-Marshall Co. and erected by the Kelly-Atkinson Construction Co. The George A. Fuller Co. has the general contract for the superstructure, and the concrete floors and roof will be placed by O. W. Rosenthal & Co. All the above principal contractors are Chicago firms. The design and construction of this freight terminal were under the direction of Thomas Rodd, Chief Engineer, and Robert Trimble, Chief Engineer of Maintenance-of-Way, Pennsylvania Lines.

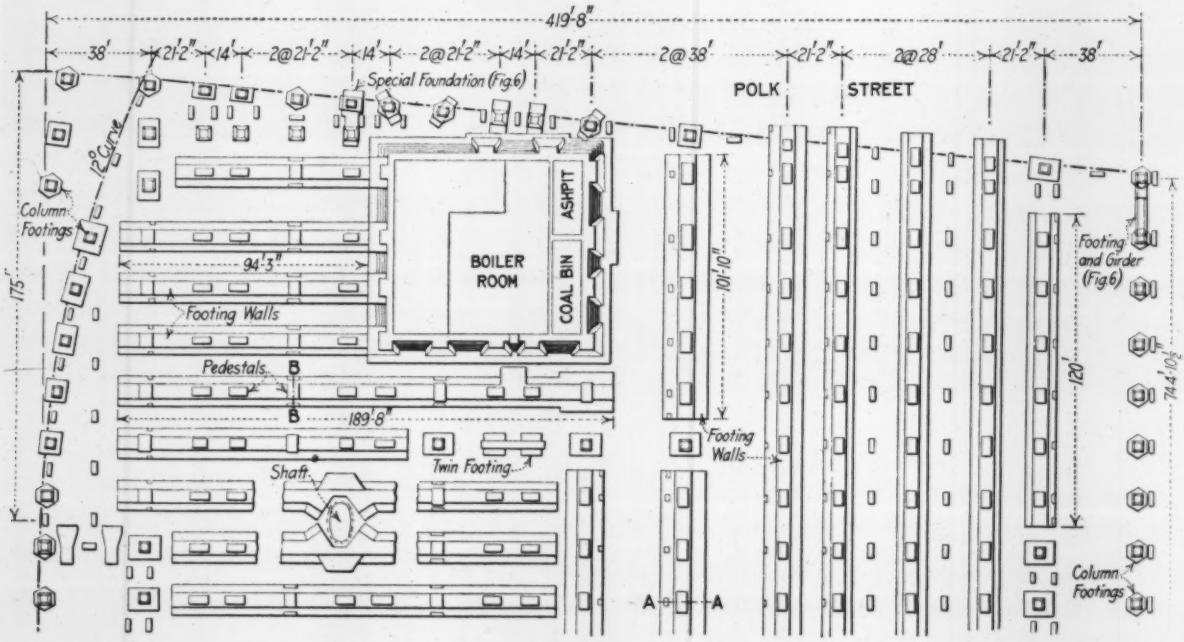


FIG. 7. FOUNDATION PLAN OF PENNSYLVANIA LINES' CHICAGO FREIGHT TERMINAL

Harrisonburg Imhoff Tanks

By William G. Myers*

Harrisonburg, Va., has just completed two rectangular Imhoff tanks and sludge-drying beds to serve a population of 5000. Intermittent sand filter beds will be installed later. Fig. 2 is a general view, and Fig. 1 shows sections of the tanks.

The side walls of the tanks are built of reinforced concrete and are braced transversely with 8-in. I-beams (Fig. 1). These I-beams also support footways and curtain walls. The precision with which these curtain walls were built was notable.

A peculiar feature of the design is the arrangement of the inlet and outlet pipes. These pipes are inverted siphons, entering the bottom of the concrete tunnel around the tank. They are "staggered" so that an 8-in. wall can be built between them. This wall is provided with ordinary channel irons set in the concrete as guides for two drop gates shown in Figs. 1 and 2, so that the direction of the current may be readily changed from one end of the tank to the other.

The bottom of the concrete tunnel is horizontal longitudinally, which admits of symmetrical and cheaper construction and has a further advantage in that a "scouring current" is maintained in both inlet and outlet conduits.

Another feature, due entirely to local conditions, was the necessity of building a retaining wall to take the earth thrust on the east side of the tank. This wall was of the reinforced buttress type (Fig. 1), but the footing was not carried to the full depth of the tank and was placed only halfway down, opposite a row of I-beams spanning the tank at this point. In the design some dependence was had in the thrust of the I-beams and in the beam or arch action of the footing of the retaining wall.

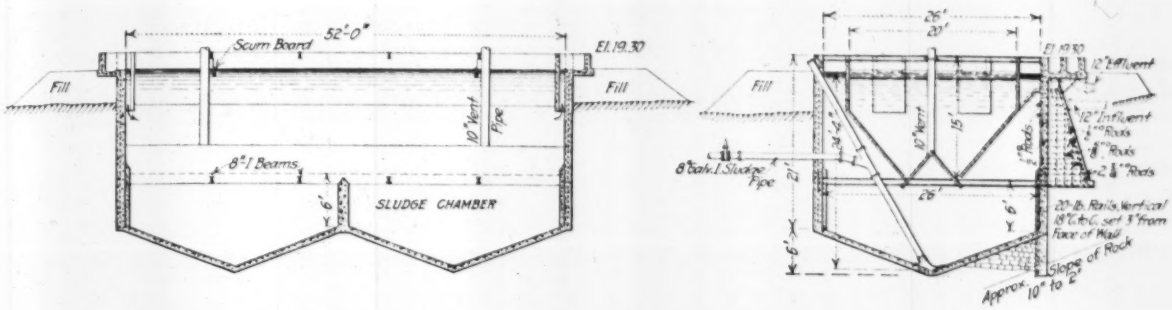


FIG. 1. LONGITUDINAL AND CROSS-SECTION, IMHOFF TANKS, HARRISONBURG, VA.

The inlet pipe is provided with a storm-water bypass and a weir by which the amount of sewage entering the tank may be determined. About 25% of this sewage is tannery waste impregnated with insoluble tannates. The consequent discoloration is not eliminated by the tank.

The whole work was done at a cost of $6757 by force account under J. F. Noll, superintendent of public works; William G. Myers, city engineer; and N. Wilson Davis, consulting engineer.

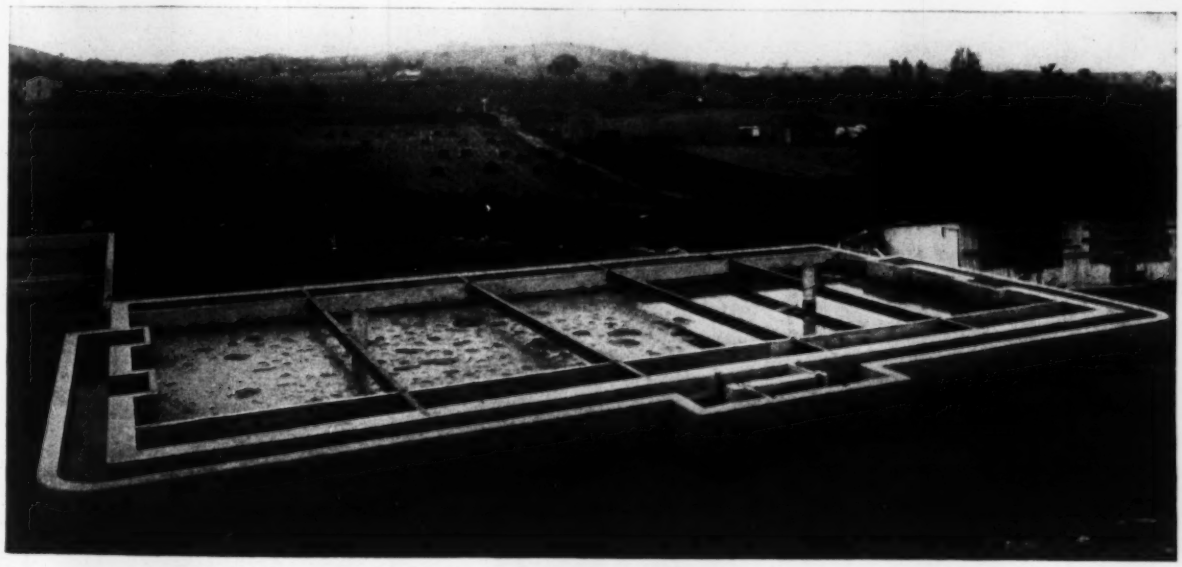


FIG. 2. VIEW OF IMHOFF TANKS AND CORNER OF SLUDGE-DRYING BEDS, HARRISONBURG, VA.

*City Engineer, Harrisonburg, Va.

Motor-Driven Vehicles are to be substituted for horse-drawn carts and wagons in the street-repair and ash- and rubbish-collection divisions of the Cleveland, Ohio, street department. Council committees have voted $68,000 to buy machines, including a large motor truck for garbage collection in the downtown section and two for hauling garbage from the downtown collection station to the reduction plant.

Scoring Water-Supply Quality*

By Theodore Horton† and E. Sherman Chase‡

In connection with the work of the Engineering Division of the New York State Department of Health in supervising public water-supplies of that state it was considered desirable that some convenient method of rating the sanitary character of public water-supplies according to a definite quantitative measure should be worked out, and our endeavor in this direction led to the following study.

There are three factors or measures that may be considered as fundamental in rating the sanitary quality of a water-supply: Contamination on the watershed; natural agencies or artificial means tending to counteract or correct this contamination; and the efficacy of these agencies as determined by laboratory analyses.

In making this study it was found that the water-supplies of New York State could be classified according to three groups, as follows: (1) Surface supplies, excluding supplies from the Great Lakes, the Niagara and St. Lawrence Rivers; (2) supplies from the Great Lakes, the Niagara and St. Lawrence Rivers; (3) groundwaters. In each group, however, the same general formula was applied, which was expressed as follows:

$$S = \frac{A}{B - C}$$

in which

S = "Score" representing the sanitary quality of the supply on a 100% scale;

A = Factor representing the condition of pollution of the watershed;

B = Factor representing natural or artificial means of purification or protection against pollution;

C = Factor representing the efficiency of this purification in the nature of a penalty based on the prevalence of B. coli in the water as delivered.

The following is a summary of the method of scoring that has been tentatively adopted for this study.

Group 1—Surface Water-Supplies

Factor A—Values for this factor are to be taken from the curve of population per square mile, the values ranging from 60 for an unpopulated watershed to 0 for a population of 1,000 per sq.mi. The figures for population per square mile in this case are to be made up of the sum of the population contributing sewage directly and indirectly, the population contributing directly being first multiplied by 5.

Factor B—Values for this factor will depend upon the means of purification, as follows:

Slow sand filters	20
Sterilization	15
Gravity mechanical filters	15
Pressure mechanical filters	10
Storage (2 weeks)	10
Storage (1 week)	5

For combined methods of purification add individual scores, but allow no greater than 10. Deduct 5 in case no coagulant is used with mechanical filters.

Factor C—This is based on a penalty for B. coli results, thus:

	Deduct
B. coli present in 100 c.c. 10-c.c. samples	10
B. coli present in 100 c.c. 1-c.c. samples	20
B. coli present in 100 c.c. 1/10-c.c. samples	30

B. coli present in other percentages deduct proportionally.

Group 2—Great Lakes, Niagara and St. Lawrence Rivers

Factor A—In assigning values for this factor consider that a population of 100,000 discharging sewage into the body of water within one mile of the intake is equivalent to a population of 1,000 per sq.mi. and that the danger from such pollution is inversely proportional to the distance beyond one mile. In case of the lake supplies consider also that the limits at which pollution will affect the supply is 20 mi. In the case of the rivers all pollution reaching the river and affecting the supply is

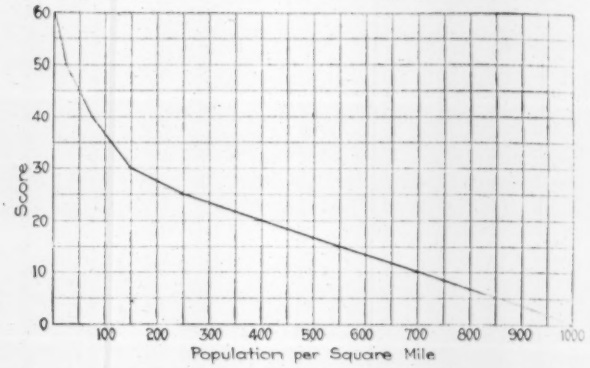


FIG. 1. POPULATION FACTOR CURVE FOR SCORING QUALITY OF NEW YORK WATER-SUPPLIES

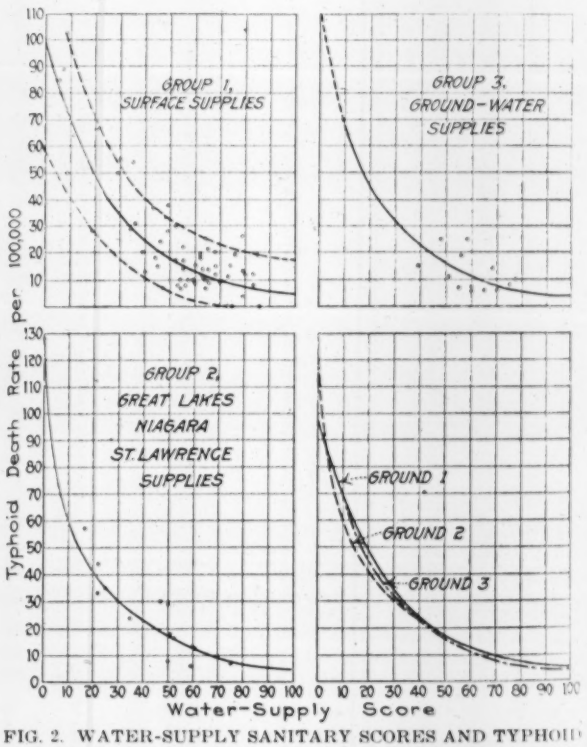


FIG. 2. WATER-SUPPLY SANITARY SCORES AND TYPHOID DEATH RATES IN SOME 90 NEW YORK MUNICIPALITIES

*Abstract of a paper entitled "A Study of the Application of the Score System to the Sanitary Quality of Public Water-Supplies in New York State," presented before the Sanitary Engineering Section of the American Public Health Association, October, 1916.

†Chief Engineer, New York State Department of Health, Albany, N. Y.

‡Assistant Engineer, New York State Department of Health, Albany, N. Y.

to be considered. The equivalent population per square mile will then equal

$$\frac{P}{100 \times D}$$

in which

P = Population discharging sewage;
D = Distance from intake in miles.
Factor B—Purification as with Group 1.
Factor C—Analytical penalty as with Group 1.

Group 3—Groundwater Supplies

Factor A—In assigning values for this factor each source of pollution within 100 ft. is to be considered equivalent to a population of 20 per sq.mi.; beyond 100 ft. and within 500 ft. equivalent to 10 per sq.mi.; and beyond 500 ft. and within 1,000 ft., equivalent to 5 per sq.mi. Use curve for Group 1 in determining factor A.

Factor B—The value for this factor will depend upon the natural character of the material in which the springs or wells are located, as follows:

Sand	40
Loam	35
Clay	30
Fissured rock and gravel	25
Solvent rock	20

If artificial means of purification are used, assign values as for Group 1.

Factor C—The penalty for B. coli results is to be double that of Group 1.

Relation Between Scores and Typhoid Death Rates

Some 90 public water-supplies in New York State have been scored, and results have been plotted in curves to show the relation between the scores and the typhoid-fever death rates. The curves for the score of the three groups were plotted independently and then superimposed with results shown in Fig. 2. The practical coincidence of the three curves indicates the approximate correctness of the values assigned for the various factors used in the general formula for scoring.

In conclusion it should be stated that the foregoing study for a score system of the sanitary quality of public water-supplies is presented as tentative only and that the figures assigned for the different factors are, for the time being, merely a suggestion. The scores actually obtained, however, correspond in a general way so closely with the knowledge of the sanitary qualities of the supplies secured through field investigations and compare so closely with the typhoid-fever death rates as to convince one of the practicability of the application of the score system to the water-supplies of New York State. A continuation of studies in connection with this score system will, no doubt, permit such modification in the values of the several factors as will make the final scores even more consistent with the knowledge of the quality of the supplies and the corresponding typhoid-fever death rates.

Increased Production of Hydrated Lime—An estimate of lime produced and sold in 1916 in the United States, including Porto Rico and Hawaii, just made by G. F. Loughlin, of the United States Geological Survey, Department of the Interior, indicates a total marketed production of 4,150,000 short tons, a gain of nearly 15% over the total for 1915, which was 3,622,810 short tons. This is the first year in which the production of lime in this country has equaled or exceeded 4,000,000 tons. Hydrated lime in 1916 showed an even more striking increase than total lime, the marketed production amounting to 710,000 tons, a gain of more than 13%. All states in which the production amounted to 5000 tons or more showed increases. These states included Michigan, Illinois and Washington, in which the total production of lime decreased.

The Late Sir Hiram Stevens Maxim

Each of the British technical journals, the *Engineer* and *Engineering*, devotes a page or more to an account of Sir Hiram Maxim, who died on Nov. 24, 1916, and who gained world-wide fame through his achievements as an inventor.

Maxim was born on a farm at Sangerville, Maine, in 1840. He was apprenticed to a wheelwright at the age of 14, and after his apprenticeship ended led a more or less roving life, engaging in various occupations, including that of a prize fighter. He also worked for a maker of scientific instruments, for a New York shipbuilding concern and for Oliver P. Drake, of Boston, a maker of gas machines. While at the latter place, Maxim invented a machine for making artificial gas from gasoline vapor, which had an extensive sale. When electric lighting attracted wide attention in the late '70's, inventors everywhere were engaged on the problem of making lamps of low candlepower to supplement the arc lamp. Maxim was a competitor of Edison as a pioneer in developing the incandescent lamp, and several processes in its production, notably the flashing of the filaments in hydrocarbon vapor, were devised by him.

In 1881 Maxim went to the Paris Exposition, representing an American electrical company of which he was chief engineer. Up to that time the numerous inventions which he had made in his native country had yielded him little in the way of return.

It was while in Paris that his attention was directed to military inventions. He made rough sketches illustrating his idea of a machine gun; and while the idea was in embryo and before any complete drawings were made, he was introduced to Albert Vickers, one of the leading British manufacturers of guns and munition. Vickers at once recognized the value of Maxim's invention, and a partnership was formed by Vickers, Maxim and Symon, vice-president of the Mexican Central Ry., who had introduced the two men to each other.

This was the turning point in Maxim's career. He settled in England, disowned allegiance to his native country, whose unjust treatment of inventors he was never tired of condemning, and devoted himself to the development of his gun and kindred inventions.

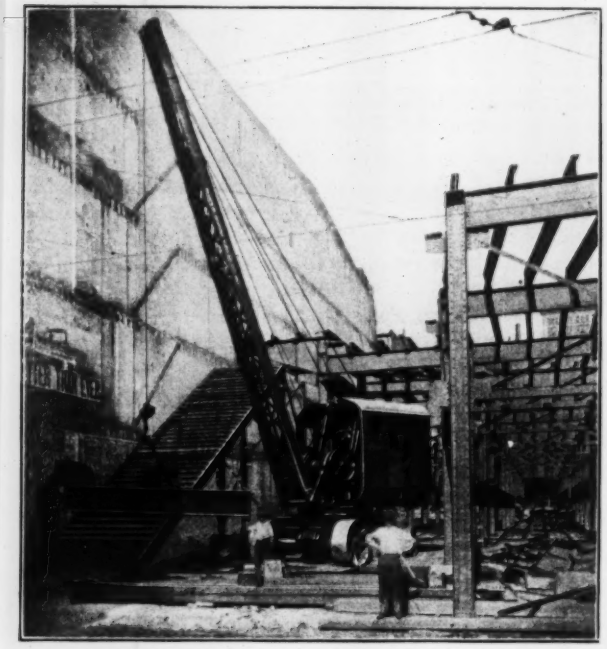
There had been, of course, numerous machine guns prior to Maxim's invention. The central idea on which Maxim worked, however, was to make the force of the explosion operate the breech mechanism, so that when an occasional cartridge hung fire for a fraction of a second, the block would not open until the explosion had actually taken place. It was not possible to patent this broad principle, as some suggestion of it had been published previously, although it had never been applied in practice. Maxim, however, surrounded his gun with a fence of detail patents so that for many years his firm had a practical monopoly of the business at immense profits.

Maxim later turned his attention to explosives, and some of the important work in the early development of smokeless powder is ascribed to him. In 1894 he made some spectacular experiments to determine the lifting effect of airplanes in connection with the problem of mechanical flight. He constructed an ingenious steam power plant developing some 360 hp., with a total weight of less than 3,000 lb. This engine drove two huge pro-

pellers 18 ft. in diameter, which in turn drove a car forward on a straight track. The planes attached to the car tended to lift it as it was propelled forward, but overhead rails prevented it from actually lifting off the rails. The experiment attracted wide attention, and on the strength of it Maxim claimed to be one of the pioneers in the development of the flying machine.

Extending Cincinnati Approach to the Covington Bridge Over the Ohio

The Covington and Cincinnati suspension bridge across the Ohio River between the cities named has entered Cincinnati on a comparatively low level through a district that is often flooded at times of high water. In order to relieve this condition and, in addition, provide



GASOLINE-DRIVEN CRANE HANDLING STEEL ON CINCINNATI BRIDGE APPROACH

an approach for vehicles nearer the business district a new approach is now under construction. It consists of a full-width steel viaduct with concrete roadway continuing the present line of the bridge on high level up to Third St. for the vehicle roadway and to Fourth St. for the street-railway tracks. The present highway approach reaches only to Front St. and the street-railway tracks to Second St.

The new viaduct, shown under construction in the accompanying view, is on a private right-of-way inside the regular city block and is over territory from which buildings have just been removed. The street-railway line will continue to a terminal now being built at the corner of Fourth and Walnut St.

The accompanying view also shows a gasoline-engine-operated locomotive crane fitted with wide tractor-type wheels for running over city streets. It was built by the Industrial Works, of Bay City, Mich., and used with success by the American Bridge Co. in the steel erection of the new bridge approach.

Building an 8-In. Macadam Pavement with a Tar and Gravel Top

By Henry Marshall Olmstead*

An 8-in. waterbound macadam road, constructed in two courses, carpeted with a surface of tar and pebbles, is a type of construction that is giving satisfaction in some New Jersey communities. This construction, described in detail in the succeeding paragraphs, costs about $1 per sq.yd., or $10,570 per mi., for an 18-ft. road; and it is estimated that it can be maintained for less than $300 per mi. per yr.

The pavement described contained 21,500 sq.yd., was 30 ft. wide except for about 800 ft. of 35-ft. width, and was about 6000 ft. long. It was constructed in the sum-

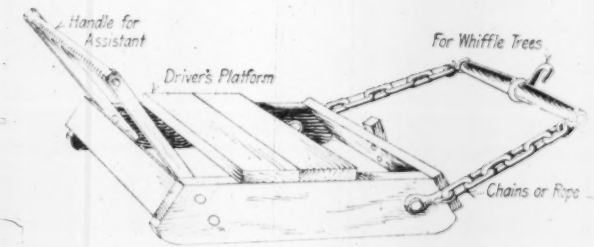


FIG. 1. SPREADER FOR BROKEN STONE MACADAM ROAD BUILDING

mer of 1916 in Bayonne Park, Bayonne, N. J. The pavement was provided with tile drains and cobble gutters, the cost of which is not included in the figures given.

The earth subgrade was given a 3-in. crown. The first course was of 2½-in. stone 3 in. thick at the gutters (edge), 4 in. at the shoulders and 5 in. at the crown. The top course of 1½-in. stone was of a uniform depth of 3 in., making the completed pavement 6 in. thick at the gutters, 7 in. at the shoulders and 8 in. at the crown. All dimensions refer to rolled depths. The stone was Rockland Lake (N. Y.) trap rock.

Special Device for Spreading Stone

As a rule, the wagons and motor trucks aided in spreading the stone. Shovels and stone rakes were used. At times conditions necessitated dumping stone in piles, in which case a special stone leveler (see Fig. 1) was used. This leveler was made as follows: There were two runners of 1½x12-in. plank 5 ft. long, with rounded and beveled ends, as shown in the illustration. To the beveled ends were nailed pieces of 1½-in. plank 7 ft. long and 10 in. wide. The bottom of these end planks came 2 in. above the level of the runners. The front end served as a plow, but allowed the stone to "flow" under its front edge. To facilitate the plowing action a 2x4-in. stake was nailed to the front piece, as shown. The driver stood on a plank platform nailed to the tops of the runner planks. The team was attached to whiffletrees by a crossbar and a pair of chains 4 ft. long.

On a measured area (1000 sq.yd.) irregular piles of stone in heaps, 1, 2 and 3 ft. high were spread and leveled to a 4-in. depth in 3 hr. at a cost of $2.10. With hand spreading this would have taken 20 men 9 hr. and cost $40. To guide the workmen, wood blocks 4, 5

*Highway Engineer, 15 Butler Place, Brooklyn, N. Y.

and 6 in. high were used to gage the depths of stone courses. Both bottom and top courses were spread 1 in. higher than the required rolled depth.

Special Methods of Building Waterbound Macadam

The successive sections in Fig. 2 on this page show the steps taken in the construction of the road.

The bottom course was rolled five times with a 12-ton roller before placing the screenings. The screenings were placed in piles and spread by the shovelful. The best results were obtained by going over the layer of stone several times and rolling while the spreading of the screenings was in progress. In damp weather the screenings stuck in the upper voids of the layer of stone and had to be coaxed into the lower voids. When bone dry the screenings were quickly rolled into place. The wetting was done after the screenings were all in place, about five trips of a sprinkling wagon being required.

After the lower course had been filled with screenings, wetted and rolled, the surface was broomed off, leaving the edges of the stones projecting about ¼ in., to "lock" the top course to the lower one. The bottom course looked like a finished waterbound macadam road prior to brooming off the surface screenings. At all times when spreading the screenings, wire and fiber push brooms were kept at hand, and they proved helpful in working the screenings into the voids.

The top course of 1½-in. stone was similarly treated. About 10 trips of the roller were required per strip of pavement. The rolled strips did not exceed 300 ft. in length. (An experienced roller man is an important factor.) On the top course the screenings were spread thinly, rolled, watered and rolled again, repeating the operation several times until the desired result was obtained. The final watering showed that the result was satisfactory when water scarcely penetrated at all, but ran off to the gutters. On completion of the operation about ⅛ to ¼ in. of screenings remained on the surface of the road.

Applying the Bituminous Mat

Before applying the tar (Tarvia B) all dust and surplus screenings were swept off the surface. Wire brooms were used to loosen the caked or crusted material, followed by fiber brooms, which left about ⅛ in. of the stones projecting. The necessity of having 1½-in. stones became apparent during this operation, for stones of smaller size were broken loose. In one place where undersized stone was used, it was necessary to put on fresh screenings, roll, water and roll again, and then rebroom the entire area before the stones would "stay put." It was necessary to keep the teams off the road after it had been prepared for the Tarvia. While brooming, ridges or fences of dust were formed along the edges of the gutters to prevent any surplus Tarvia reaching them.

The Tarvia was applied by the manufacturer, the Barrett Manufacturing Co., with a 1200-gal. Packard motor truck. The truck distributor was equipped with an 8-ft. spraying device that applied the material under 20-lb. pressure. Four trips covered a 30-ft. width of road. The penetration was from ½ to 1 in. into the surface of the road. The Tarvia was applied only when the road was perfectly dry. It required about three-quarters of an hour to empty a 1200-gal. truck. The amount distributed was about 0.54 gal. per sq.yd. In another season or so, ¼ to ⅓ gal. more will be required.

A sufficient area of surface should be prepared to use up the whole 1200-gal. truck load, for once the distributor has started spraying, the operation should not cease until that particular "ribbon-like" paint coat is completed; stops cause an excess of tar at some point, which is undesirable.

In mild, sunny weather the Tarvia was allowed to penetrate for 24 hr., but in cold, damp weather it required about twice as long. To protect concrete curbs and other roadside structures from tar splashes, two men

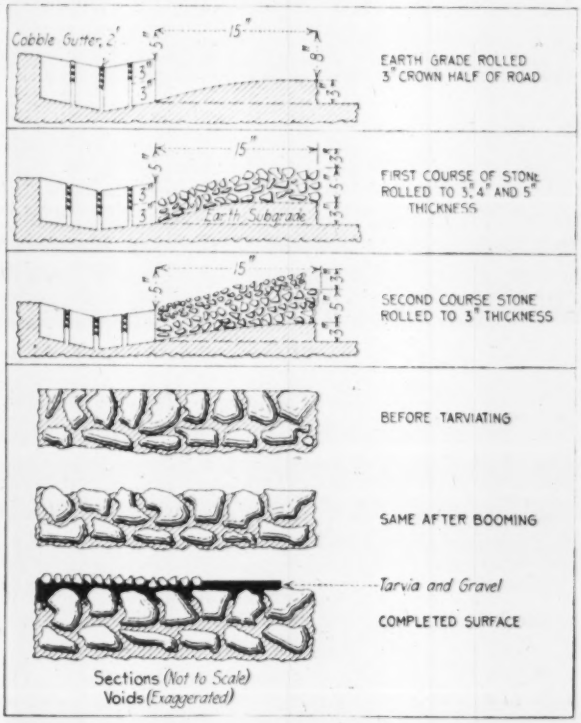

Cobble Gutter, 2'
15"
EARTH GRADE ROLLED 3" CROWN HALF OF ROAD
FIRST COURSE OF STONE ROLLED TO 3", 4" AND 5" THICKNESS
Earth Subgrade
SECOND COURSE STONE ROLLED TO 3" THICKNESS
BEFORE TARVIATING
SAME AFTER BOOMING
Tarvia and Gravel
COMPLETED SURFACE
Sections (Not to Scale)
Voids (Exaggerated)

FIG. 2. CROSS-SECTIONS SHOWING CONSTRUCTION OF BAYONNE PARK ROAD

walked alongside the motor-truck distributor holding a shield of tar paper over all that part of the work which was to be protected.

Clean, washed, pea gravel, free from sand, the gravel particles measuring $\frac{1}{16}$ to ¼ in. in size, was used to cover the tar coating. This was spread from piles alongside the road, 1 cu.yd. covering 100 sq.yd. of surface. Wooden garden rakes were used to spread the gravel and to remove any large-size stones. It required 14 men 8 hr. to spread 4800 sq.yd. After applying the gravel the surface was twice rolled, and the dust ridges at the gutters were removed.

Cost Data

Exclusive of grading, gutters, bridges and drains, the following is an itemized cost analysis: Stone, 38.51c. per sq.yd.; screenings, 12.2c. per sq.yd.; pea gravel, 2c.; Tarvia B, 4.59c.; teams, 1.6c.; rolling, 10.3c.; labor, 30.8c.; total, $1 per sq.yd.

Under more favorable market and labor conditions, it is estimated that the pavement could have been laid for 75c. per sq.yd.

Legal Obstacles to Street Widening and City Planning

By Charles K. Mohler*

Perhaps the greatest need in laying out and building cities is unselfish and constructive forethought to discover and provide for future requirements. How little of this has been exercised by the city and suburban subdivider is evidenced on every hand in nearly every American city.

One of the most common changes necessary to meet new and changing conditions is the widening of streets.[1] With the very best legal equipment possible to provide, street widening is a difficult, slow and expensive undertaking. Such being the case, it is of very great importance to have all the legal obstacles removed so far as possible and at the same time provide the fullest measure of legislation for undertaking constructive work. Every city should possess and use the right to establish new street lines for opening or widening, ahead of the time at which the improvement is to be carried out, and to place the necessary restrictions on the use and occupancy thereafter, between the old and new lines. When it is definitely known that changes and growth of a city will require in the future the opening of a new thoroughfare or the widening of an old one no time should be lost in establishing the new lines so as to prevent the erection of new and costly buildings on the area to be taken for street purposes. To illustrate, suppose it is reasonably certain a given street will have to be widened in 10 years. Let one property holder be ready to erect an expensive permanent building at once. Unless new lines are established, he can build out to the old lines without any restrictions and is justly entitled to damages when the improvement is made and the front of the building is torn away. With new lines established, however, any building erected beyond the new limits thereafter would have to be removed when the widening was effected, without any claim for damages. In case a property holder wished to erect at once a building to the full limit of height he could erect the main portion to the full height on the new line. Beyond this he should be allowed to erect to such height as he would deem to his interest for the time it would be allowed to stand. When the street was widened, the "encroaching" portion would have to be removed without any cost to the municipality. The building could be so designed in the first place that the removal of the portion beyond the new line would leave the main portion intact.

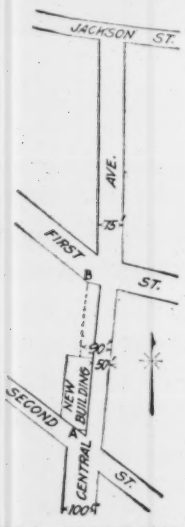


FIG. 1. STREET-WIDENING OBSTACLE

If unrestricted improvements are made but a short time before widening is undertaken, the claims for damages are of course proportionately higher. It not infrequently happens that when an opening or widening is contemplated, property holders will deliberately erect buildings on the lines of the contemplated improvement with the sole purpose of presenting claims and securing damages. The municipality should have the right to deny building permits on the affected area as soon as any official action is taken on any contemplated opening or widening.

As a concrete example of how a widening may be discouraged, if not rendered impossible, reference may be had to Figs. 1 and 2. Fig. 1 shows widths and intersections of Central Ave., a main traffic thoroughfare in an industrial district. South of 2nd St. it is 100 ft. wide; between 2nd and 1st St. it is only 50 ft.; between 1st and Jackson it widens out again to 75 ft. It terminates at Jackson. To take care of future traffic needs this street should not only be widened along the line AB to 80 or 90 ft., but should be carried through to the north beyond Jackson St. The area at the northwest corner of Central Ave. and 2nd St., marked "New Building," was, up to about six months ago, only occupied by cheap shacks. It is now occupied by a four-story and basement brick building, as shown by Fig. 2. Under proper control the new line AB could and should have been established and the necessary area reserved for widening. Under that arrangement the cost for widening in the future should not have been more than the value of the land taken, less the assessed benefits. To widen the street now, however, the value of the greater portion, if not all, of the building will have to be included in addition. This example is taken from a Pacific coast city.

FIG. 2. NEW BUILDING IN WAY OF STREET WIDENING

Looking north on Central Ave. (Fig. 1) from corner of Second St. "New building" shown on left

When the portion of a street which should be widened is faced with new and expensive buildings, it proves such a serious handicap that the widening may be put off for years, if indeed it is undertaken at all. With little or no prospect of the street being widened and extended there is little if any encouragement for a higher development along the adjoining property to meet new and better future use. If for any reason the city acquires land for street opening or widening before the work is actually carried out, the abutting property holders should be allowed the use of the land, if they desire, and be charged an adequate rental for its use.

In addition to the expense and difficulty of the municipality's actually acquiring ownership of property, there are the claims and opposition of leaseholders to be satisfied. To secure proper restrictions against claims for damages by leaseholders is another important reason for establishing new street lines well ahead of the time the improvement is actually to be carried out.

Present experience shows that the average life of most city buildings is not much over 30 years. If no alterations, repairs or new buildings are allowed without

*Consulting Engineer, 150 N. Hill St., Los Angeles, Calif.

[1]The advantages and needs of "Acquiring Excess Land" were treated by the writer in "Engineering News," July 6, 1916.

keeping back to the new lines, the widening will be accomplished gradually and almost automatically. If on the other hand the widening cannot wait the full length of time for automatic adjustment, then damages would need to be awarded for useful buildings that were erected before the new lines were established and that had to be destroyed. This method has been successfully used in Paris and Hamburg.

It is believed that in the United States the right to establish new street lines in the way outlined, is possessed only by the municipalities of the State of Pennsylvania. It has been employed to widen at least three streets in the business district of Philadelphia, Chestnut, Arch and Walnut. The first ordinance was passed in 1870, the second in 1884, and the third in 1894. The widening of these streets has been nearly accomplished now and at very little cost to the city. The right has stood the test of litigation.

It seems the common sense and logical means of meeting future growth and needs of cities for increased street capacity.

It is to be hoped that all states may take steps that will put them in the forefront with rights by which municipalities may make normal growth and development, without burdensome legal handicaps.

Earth-Dam Failure in Bohemia Due to Bad Design

Details of the earth dam across the Weisse Desse River in Bohemia, Austria, on Sept. 28, 1916, as given in a recent issue of the *Schweizerische Bauzeitung*, show that the dam was of entirely inadequate design and construction and that its failure was only to be expected. The data are quoted from a report of E. Grohmann in the Austrian journal *Die Wasserwirtschaft*.

The dam was 41½ ft. high above valley bottom, or 47½ ft. high above foundations. The crest width was 13 ft., the base width 149 ft., and the length about 800 ft. There was approximately 40,000 cu.yd. of earth in the dam. A spillway of 200-ft. length was provided.

The embankment had a water-side slope of 1 on 1½ in its upper portion, with two berms; below the second berm the slope was 1 on 2. The downstream slope was a continuous 1 on 1½ slope. These proportions are slender. Moreover, the material was not tight, according to all the evidence and the appearance of the embankment after the failure.

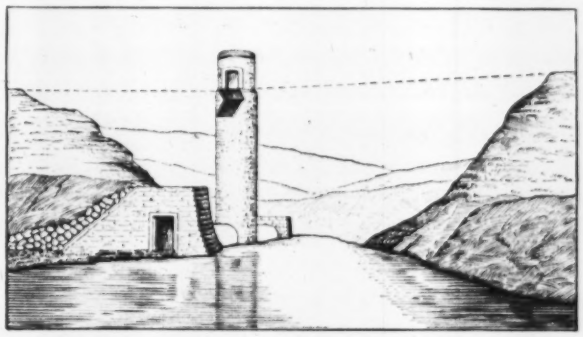
The valley soil found near the dam was used to construct the embankment. It was regarded as clay loam, and by depositing it in 16-in. layers, which were rolled by power rollers to a 12-in. thickness, a tight body was thought to be obtained. It is stated that experienced engineers before construction warned against use of the local material, which is débris of granite disintegration deposited at this particular part of the valley because the slope changes (going downstream) from 2% to 4 or 6%. According to Mr. Grohmann, the borrow pits show that the material is entirely unsuited for dam construction, though excellent for plain fill work such as a railroad embankment. The material is described as gritty and easily affected by percolation.

Moreover, the deposition in layers is described as having been unsuccessful with respect to producing a consolidated body. The faces of the break show the original 12- to 16-in. layers very distinctly. Consolidation by the roller did not extend down more than 4 or 5 in. in each layer.

The dam had a clay cutoff and water-side facing. However, examination of the faces of the break did not show any material difference between the body of the dam and the facing layers. The cutoff was carried down 15 ft. or more below ground, was about 10 ft. thick, and had a sheetpile wall along its upstream side. The clay layer was continued up the water slope to the crest of the embankment, with a thickness of about 3 ft. at the top. A 12-in. stone pavement on 16 in. of broken stone protected it against wave wash.

The outlet conduit through the dam was supposed to have cutoff walls under it extending 10 ft. or so into the ground below and backfilled with puddle. Both conduit and valve shaft do not show any cutoff, however, at least so far as the upper half of the conduit wall is concerned.

Failure appears to have originated through percolation of water along the outlet conduit. A small stream of clear water was seen to issue from the embankment just above the top of the conduit arch a short time before the



THE WEISSE DESSE DAM WASHOUT
Sketched from a photograph

failure, and in less than a quarter-hour it had increased to a stream of dirty water several inches through. Collapse of the dam over the conduit followed soon, and the water flowing out tore a large gap in the embankment (see sketch, made by the *Schweizerische Bauzeitung* from a halftone cut). The reservoir behind the dam was only about three-quarters full at the time the accident occurred.

An interesting auxiliary item is that it is said there were various small leaks at the toe of the dam when the reservoir first was filled. To stop the leakage a low embankment was placed along the toe. This early leakage seems to point quite directly to the permeability of the dam body. An equally interesting fact is that the outlet conduit is said to have been founded on piles. Whether these piles contributed in any way to the washout has not been determined.

Mr. Grohmann does not hesitate to blame the failure upon incompetence and bad design.

A Motor Toll Road is to be built in Kansas, if the company incorporated as the Auto Traffic Co., of Fort Scott, fulfills its charter requirements. The proposed road will extend from Fort Scott to Pittsburg, 32 mi. The toll-road company proposes to conduct a freight and passenger business on its own account and to collect tolls from other motor-car owners for use of the road. The company has the same right of eminent domain that a railway has. It is incorporated under an old "post roads" act which has not been used in Kansas for more than 40 years. The capital is $50,000.

One-Span Concrete Arches on Sides Widen Two-Arch Stone Bridge

In Cuyahoga Falls, Ohio, a 56-year-old masonry bridge on the line of Portage St. across the Cuyahoga River has for some time been of insufficient width though of sufficient strength to carry the traffic. It was decided to widen the bridge and at the same time utilize the existing structure by building a reinforced-concrete bridge on each side and extending the roadway over the whole width of the three structures, making in so far as the roadway is concerned, one structure. The old bridge, however, had a pier in the middle of the river and two spans approximately 40 ft. each; the new sections were made in single spans of 95 ft., slightly unsymmetrical about the crown, which itself is not exactly in line with the center of the whole middle pier.

The details of the design are shown in Figs. 1 and 2. The parapet walls and roadway surface of the old bridge were removed so that the new roadway could span, with its crown, from curb to curb of the additions. This old roadway was 20 ft. wide and is replaced with a 38-ft. roadway and two 7-ft. 6-in. sidewalks, the full width of the street which it carries. The new arches have solid ribs carrying on crosswalls a slab floor. The ribs were built to within 1 in. of the sides of the masonry arch, a definite separation of that amount being made by 1-in. boards. The new slabs overlap the masonry arch and are also separated therefrom by a 1-in. space. The new roadway is of brick resting on a sand bed covering the slab on the new sections and a newly built 6-in. concrete slab on the old fill.

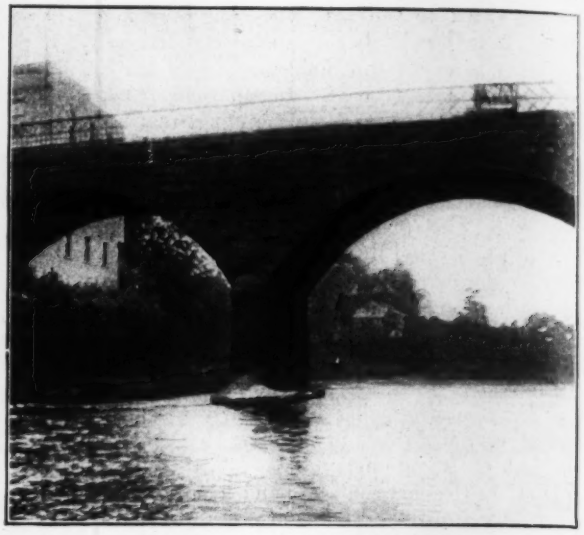


FIG. 3. OLD PORTAGE ST. BRIDGE

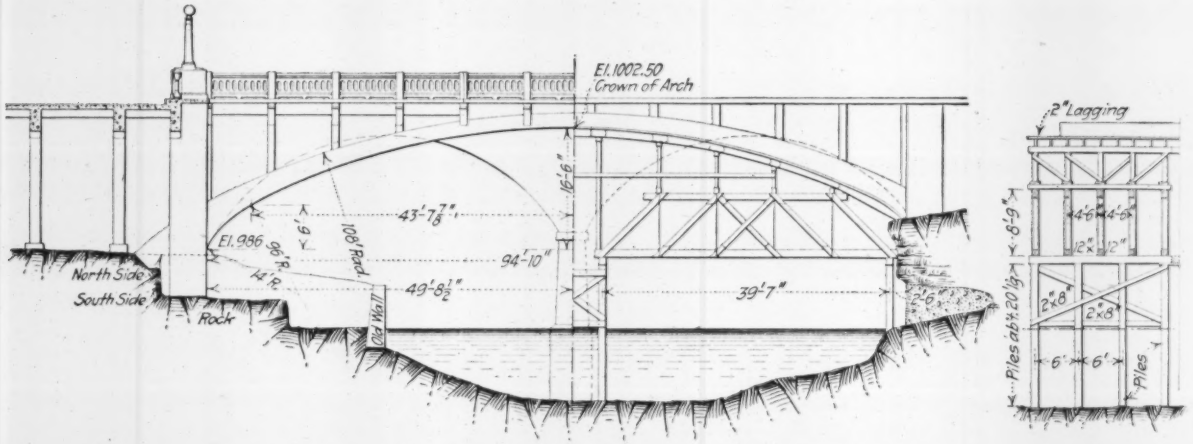


FIG. 1. ELEVATION OF PORTAGE ST. BRIDGE, CUYAHOGA FALLS, OHIO, SHOWING OLD AND NEW STRUCTURES AND FALSEWORK

The most difficult problem encountered was that of building the falsework to support the masonry. The new concrete arch ring is about 25 ft. above the mean water level. Four timber bents, one on each side of the stream, and two near the center pier were built. These bents

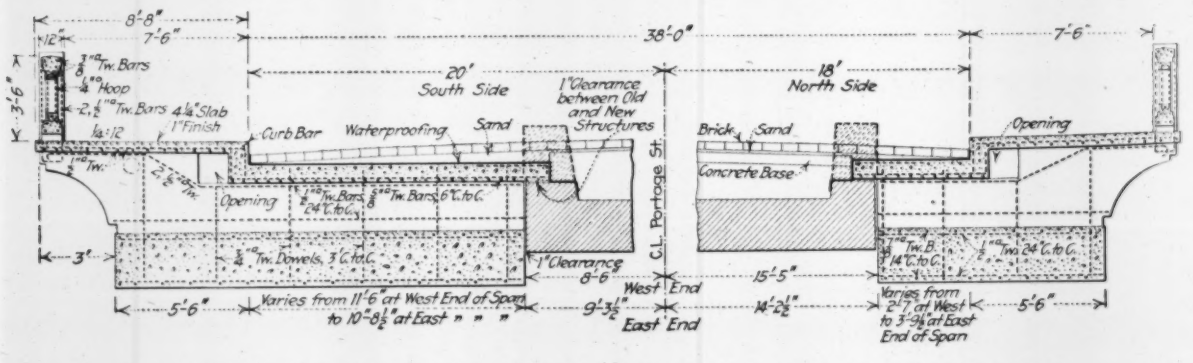


FIG. 2. CROSS-SECTION, SHOWING METHOD OF WIDENING BRIDGE AT CUYAHOGA FALLS

were used to support a series of trusses so constructed that, after being used to support the arch ring on one side of the old bridge, they were used again to support the ring on the other side. Each bent extends the full length of the old and the new work.

Posts used near the center of the stream were placed whenever the depth of the water, which depended largely on the operation of a dam above, would permit.

Ten trusses, in two units of five each, were built up of wooden planks and securely bolted together. The overall length of these trusses was a few inches less than the clear span of the old masonry. Above the trusses additional falsework was built up to support the deck that carried the concrete arch ring. When one side had been poured and the concrete set, the centers were struck and the additional falsework removed. The trusses were

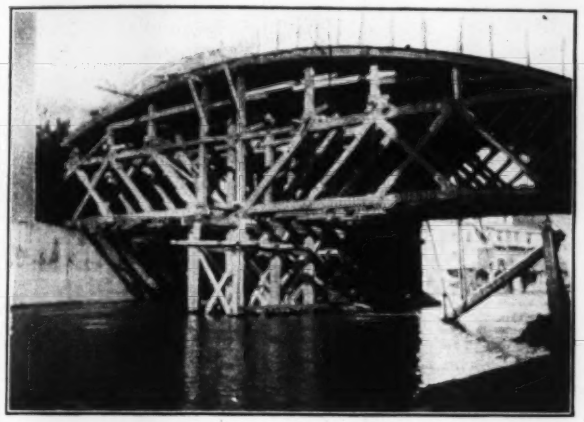


FIG. 4. FALSEWORK IN POSITION

then slid along on the bents under the old bridge, and the operation was repeated on the other side.

The work is being done for Summit County under the supervision of Edward Paul, County Engineer, Akron, Ohio, and Wilbur J. Watson & Co., Consulting Engineers, Cleveland, Ohio, by The Cavanagh-Linn Co., General Contractors, of Cleveland.

Annual Meeting of the American Society of Civil Engineers

The sixty-fourth annual meeting of the American Society of Civil Engineers, Jan. 17-18, will be chiefly notable as the first held in the United Engineering Society Building, soon to house all four of the great national engineering societies. The main floor of the auditorium, which seats about 800, was filled to overflowing. The first on the program was Charles F. Rand, President of the United Engineering Society, who made an appropriate address welcoming the civil engineers into the fold.

The final reports of three special committees were read and accepted—those on concrete and reinforced concrete, on the valuation of public utilities, and that appointed to investigate conditions of employment and the compensation of civil engineers. Progress reports were submitted by the committees on engineering education, on steel columns and struts, on road construction, on stresses in railway track, and that to codify present practice on the bearing power of soils for foundations.

The report on concrete and reinforced concrete included an explanation of the alleged shortcomings of the committee. This was kindly received, and the work of the committee was given praise. E. W. Stern, New York City, moved to have a new committee appointed to continue the work, and the meeting voted to refer this suggestion to the Board of Direction for consideration. The report on the valuation of public utilities received high praise. A meeting will be held later to receive discussion on this report.

The report on the conditions of employment and compensation of civil engineers aroused the most interest of any of the committee reports. The opinions expressed from the floor seemed to be that the average salary of $4140 for members of the society was an optimistic estimate. The motion to establish an employment bureau was again brought before the society in a letter of P. M. Churchill, and the suggestion received the indorsement of Gen. William H. Bixby, and E. W. Stern. The idea appeared to make a favorable impression on the majority of those present. This motion and also one to have a special committee appointed to investigate opportunities for American engineers in foreign lands were referred to the Board of Direction for consideration.

The progress report of the committee on engineering education was chiefly an address by Dr. Charles R. Mann, of the Carnegie Foundation, in which he stated that the Foundation's report would be ready for distribution in the course of a few months. He further stated that a second questionnaire (as to the qualities that promoted success in an engineering career) had confirmed 94 to 6 an earlier statement that improvement in mentality (honesty, tact, resourcefulness, energy, self-esteem, etc.) was more important than better technical training. He believed that two keys to best mental development were what pedagogs called "motivation" and "interrelation." In practicing engineers these were typically manifested respectively by "interest in work" and "common sense." The study of American technical schools showed him that they needed to arouse more the maximum interest of students in their school work, and to secure a much greater coöperation between now separate collegiate departments, such as physics, mathematics, languages, engineeirng, etc.

The progress report on stresses in railway track told of tests conducted on the Illinois Central R.R., near Champaign, Ill., and on the Delaware, Lackawanna & Western, R.R., near Dover, N. J. Laboratory tests of the distribution of loads on various kinds of ballast are also being conducted at the University of Illinois. During the year contributions totaling $7500 were received from the Bethlehem, Cambria, and Lackawanna Steel companies, for the work of the committees on steel columns and struts and on stresses in railway track. The society expended $4115.07 on the work of the various special committees.

The award of the Norman Medal was announced to J. A. L. Waddell for his paper "The Possibilities in Bridge Construction by the Use of High-Alloy Steels." The J. James R. Croes Medal was awarded to C. E. Smith for his paper, "History of Little Rock Junction Railway Bridge." The Thomas Fitch Rowland prize was awarded to E. L. Sayers and A. C. Polk for their paper, "The Lock 12 Development of the Alabama Power Co., Coosa River, Alabama." The James Lowrie prize was awarded

to William G. Grove and Henry Taylor for their paper, "Reconstruction of the Norfolk & Western Ry. Bridge over the Ohio River at Kenova, W. Va." The Collingwood prize for juniors was awarded to Harold Perrine and George E. Strehan, for their paper "Cinder Concrete Floor Construction Between Steel Beams."

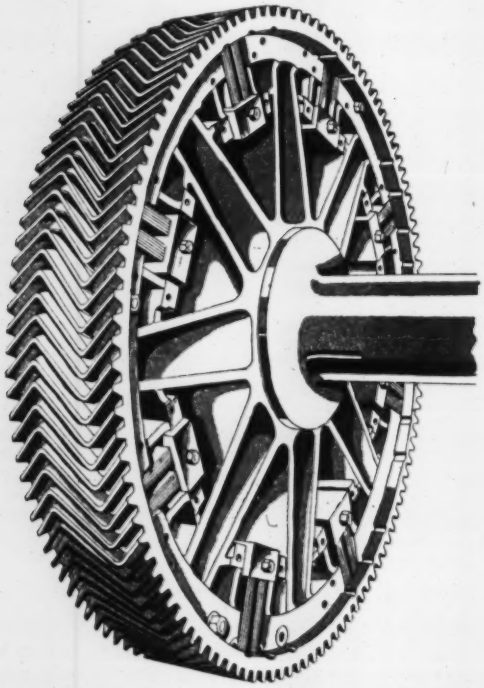
The new members of the nominating committee, to select candidates for office in 1918 are: R. S. Buck, New York City; D. B. LaDu, Albany, N. Y.; J. S. Conway, Washington, D. C.; A. J. Himes, Cleveland, Ohio; A. O. Ridgway, Denver, Colo.; L. C. Hill, Los Angeles, Calif.; W. C. Hammett, San Francisco, Calif.

The officers elected for 1917 are: President, George H. Pegram, Chief Engineer of the Interborough Rapid Transit Co., New York City; Vice-Presidents, George W. Kittredge, Chief Engineer, New York Central Lines, New York City, and George S. Webster, Director of the Department of Docks, Wharves and Ferries, Philadelphia, Penn.; Treasurer, George W. Tillson, Consulting Engineer of the Borough of Brooklyn, New York City; Directors, Alfred D. Flinn, New York City; L. D. Rights, New York City; W. R. Hill, Albany, N. Y.; Arthur P. Davis, Washington, D. C.; W. L. Darling, St Paul, Minn., and R. H. Thomson, Seattle, Wash.

A report of the discussion on road materials and construction appears elsewhere in this issue.

Large Spring-Cushioned Gear for Electric Locomotive

Marked improvement in smoothness of operation and low maintenance cost was secured in the case of the geared single-phase locomotives of the Lötschberg Ry. (Switzerland) by removing the rigid gears and putting in their place spring-cushioned gears. One of these is illustrated herewith, from the *Schweizerische Bauzeitung* of Sept. 30, 1916, where Prof. W. Kummer, of Zürich, describes the results.



SPRING-CUSHIONED GEAR FOR ELECTRIC LOCOMOTIVES

The railway has 14 locomotives, of which the 13 here in question have five coupled driving axles and leading and trailing axles. There are two 1,500-hp. motors, each gearing down a layshaft; the two layshafts drive the middle driving axle by a triangular driving bar on each side.

Serious operating troubles developed in certain of these engines late in 1914, within a short time after the line was opened to traffic. Mechanical surges between the motors and the driving axles appeared at certain speeds. Within the speed range 38 to 42 km. per hr. these surges produced a pounding sufficient to loosen the layshaft crankpins. Examination showed that the trouble was due to slight irregularities of motion, owing to unavoidable imperfections of workmanship, which caused a hunting effect involving the inertia of the moving parts and the elasticity of the system. It was concluded that the trouble would be cured if the system could be made less rigid. The spring-cushioned gear was tried for this purpose, being applied first to one layshaft of the most troublesome locomotive.

The oscillations or surges disappeared completely; thereupon a similar gear was applied to each of the other refractory engines, with the same success. Experience soon showed that important advantages were gained in reduced wear of the shaft bearings. In the case of the layshafts the wear of the bearings was reduced to one-eighth; an equally distinct gain was made in the maintenance of other parts of the drive. As soon as this fact became evident, the spring gear was applied also to those locomotives in which no trouble from surging or pound had occurred.

Up to now these locomotives have averaged 135,000 km. each, and the wear of the gears is small.

Construction and Maintenance of Catchbasins and Inlets

Quite a treatise on catchbasin construction and maintenance is the report of the discussion at the November meeting of the sanitary section of the Boston Society of Civil Engineers, printed in full in the January issue of the "Journal" of the society. Various types of catchbasins are described, and experience and cost data in cleaning them are given. Frank A. Marston, secretary of the sanitary section, summarizes the discussion as follows:

1. Where combined sewers or drains are laid on very flat grades, not providing self-cleansing velocities, catchbasins are useful to catch detritus in order that it may be removed more economically than from the sewers or drains.

2. A considerable saving in the cost of cleaning catchbasins can be effected by the use of a suitable motor-truck equipment.

3. Of the two examples of motor-truck apparatus described, that developed by George A. Carpenter, city engineer of Pawtucket, R. I., appears to meet the conditions in New England cities where the Otterson machine failed, although successful in the West.

4. Where self-cleansing velocities can be obtained in the drainage system, from the surface connections through to the point of discharge, inlets without traps should be built in preference to catchbasins, both for economy and better service. It may be more economical to construct a single catchbasin in the main drain at the head of a section laid on a very flat grade rather than to build catchbasins for a large number of surface connections.

5. Oil should be applied to the water in catchbasins, to prevent the breeding of mosquitoes.

6. Catchbasins should be regularly inspected and should be cleaned after each severe storm if necessary.

7. Catchbasins should be built only where necessary, because of special conditions, and not as a matter of custom, as appears to be the practice in some cities.

8. Unless catchbasins are actually catching grit which would otherwise be deposited in the sewer or drain, they should be replaced by inlets.

The motor-truck equipment used at Pawtucket by Mr. Carpenter is a Standard chassis with a 32-hp. engine. The steel body made by the Monahan Vehicle Co., Providence, R. I., holds 3.4 cu.yd. The dump body of the truck is provided with a hydraulic lift, operated by the transmission system of the engine. Back of the driver is a small crane carrying an orange-peel bucket, which is controlled and operated by oil or air pressure. The capacity of this outfit is 9 to 12 loads, or 23.4 to 31.2 cu.yd. per day. The average cost of cleaning basins by this method was 75c. per cu.yd., which was one of the lowest figures cited.

The Otterson machine referred to above is known as the Auto Eductor and consists of a centrifugal pump, sand eductor and dump body mounted on a Kelly-Springfield motor truck. The dump body has two chambers, one for settling the solids and the other to serve as a supply chamber for the pump. The eductor is a patented device consisting of an orifice and throat, as in sand ejectors. It is claimed that the catchbasins in Portland, Ore., have been cleaned in this manner for 60c. per cu.yd.

Adapting Motor Trucks to Desert Work

Second-Prize Motor-Truck Maintenance Article in the "Engineering News" Prize Contest

By Edwin H. Warner*

The author's personal experience, covering 20 months, with truck operation over country roads in Kern River Valley, Kern County, California, permits him to offer several comments that may be of service in spreading knowledge about certain features of design, equipment and operation which decidedly affect the success and economy of motor haulage, especially under difficult desert conditions.

The truck design of today varies little from that of the ordinary car, except in a somewhat heavier chassis and wheels. It is designed for moderate grades and smooth streets; if only moderately successful under other conditions, that fact is a matter of congratulation and not a reproach.

The road conditions in the Kern River Valley are: A rise of 2600 ft. from the railroad station at Inyokern to Walker's Pass. The grades are moderate with short sharp pitches for the first 8 mi. On the remaining 8 mi. the grade and sharpness of the pitches as well as their length increase. From the Pass the road drops 2000 ft. in 8 mi. and is followed by 20 mi. of water grade along the river bottom; then up the North Fork of the river for 12 mi. over a somewhat rolling country. As a whole the road is largely in sand, with occasional soft spots, for the total distance of 58 mi. The character of the road is such as obtains in country districts remote from the railroad—unworked except as the small tax (paid in money and labor) permits.

The temperature varies between 30° and 116° F.

The highest-priced two-ton truck on the market was used, but changes were necessary and were made along the following lines:

The gear ratio was such that too much low-gear work was called for; many of the pitches in the first 16 mi. were a shade too steep for the intermediate; this gear ratio was changed and a reduction in running time resulted. In spite of the change, there was considerable loss of time due to the heating of the engine; a 5-ft. section of 8-in. pipe was placed on the running board, connected up with the circulating water, and the trouble was remedied.

The carburetor used was all that a self-respecting carburetor should be on a $6000 family car, but was unreliable under conditions of low speed, dust and dirt. This was changed for one costing less money, but better adapted to the work.

The high summer temperature caused trouble with the lubrication; this was met by varying the oil with the season. The gasoline supply was inadequate for a round trip and was supplemented by heavy cans on the running board.

The double tires on the rear wheels cut badly in the groove between them, and were generally unsatisfactory, for they would straddle the track of the front wheel and break a track for themselves in the yielding sand. They were replaced with single tires, and the result was satisfactory.

The author's recommendations for desert service are:

1. Study the grades and road conditions and select a gear ratio that will reduce the low-gear work to 10% or less of the distance run.

2. Add at least 100% to the radiator capacity.

3. Select a carburetor whose best performance is at speeds not exceeding 15 mi.

4. Under high atmospheric temperatures watch your lubrication closely and vary the oil according to the season.

5. Increase your gasoline supply so as to cover the round trip from the railroad point; if additional gasoline is carried in cans, have them specially made of No. 14-gage galvanized iron with outside patches on the corners; strap cans tightly to running board.

6. Strengthen the running-board hangers by 100%.

7. Truss the chassis with two 1-in. diagonal rods to avoid weaving of frame, especially under conditions of a rear overhung load.

8. Avoid double tires on the rear wheels.

9. Provide a governor, limiting the speed to 12 mi. per hr., so attached that the driver cannot readily disconnect it.

10. Provide the driver with a well-upholstered comfortable seat and furnish curtains on the cab as a protection against inclement weather.

11. Arrange a speed schedule and insist upon its maintenance, thereby reducing to a minimum the driver's sociable desire to talk with acquaintances along the road and eliminating the 20-mi. gait he would otherwise hit to make up for lost time.

*Title Insurance Building, Los Angeles, Calif.

The Miami Valley Flood-Protection Work

III—Dam and Outlet Problems

Proportioning Large Earth Dams and Their Spillways; Design of the Great Outlet Conduits; Discharge Channels Designed to Destroy Energy of Discharge by Standing Wave; Details of Design Developed by Experiments

Earth dams are to be used for protecting the Miami Valley against future floods. Because these dams must be safe under all conditions, a century from now as well as when just completed, their design was studied with unusual care. The engineers aimed at ample safety of the structures, and definite knowledge with respect to all conditions of service and operation. This is best shown by the adopted dam section, Fig. 2, and by the elaborate course of large-scale experimenting through which the discharge channels were developed.

These dams will be located above large cities, and their failure would result in enormous damage. They will stand dry for years at a time and then may suddenly be subjected to full head of water, a condition which in itself raised question on the part of some residents of the valley. They must not only be safe under normal conditions, but also safe even if supervision and maintenance should become lax. They must be foolproof. Their outlet conduits must be permanently open and unblockable. The discharge of large volumes of water at high spouting velocities must be rendered powerless to do damage.

FIG. 1. EXPERIMENT STATION WHERE HYDRAULIC-JUMP TESTS WERE CARRIED OUT

The greatest of these problems, perhaps, was that of the discharge conduits, which under maximum conditions will deliver the water at a flow-velocity of nearly 60 ft. per sec. The Taylorsville dam, which has the largest conduits, is designed for a discharge of 55,000 cu.ft. per sec., nearly as much as the present safe flood-flow capacity of the 600-ft. channel of the Great Miami at Dayton. The power residing in this discharge must largely be dissipated before the water can safely be delivered to the river channel below. Even within the conduits the destructive ability of the high-velocity flow is so great that local defects in the structure of the conduits might lead to destruction.

Protection of the conduit entrances from obstruction by drift carried down in floods also called for attention. The engineers did not look on drift as a serious source of trouble, but the fact that residents of the valley had strong fears in this regard made it desirable to provide efficient protection.

Design of the Dams

Satisfactory dam sites were located for the construction of earth dams. Thorough exploration by borings was undertaken in order to find rock foundations for the outlets and spillways. This search succeeded, although one of the dams had to be shifted from the preliminary location to get the desired rock foundation for the spillway at suitable depth. The rock foundation at all the dam sites, except Lockington, is geologically known as the Cincinnatian formation and consists of layers of hard limestone interstratified with shale or hard clay. Investigations have satisfied the engineers that this formation will provide a foundation well suited for the outlet works and spillways. At the Lockington dam site the ledge rock is Cedarville limestone, a comparatively hard rock of massive bedding. At those dams which have spillways outside the dam structure itself, satisfactory rock channels for the spillways were found. The dams themselves in all five cases will be built on earth bottom. This condition and the nature of the materials available near-by dictated earth-embankment construction. Basin capacities were fixed by the spillway levels chosen. Generally, these were governed by natural limits of elevation—the adjoining ridge elevations or the location of towns that could not be flooded (as at Taylorsville) or the limits imposed by economy in railway readjustments (as at Huffman). At Englewood the economical and desirable capacity of the reservoir, rather than the height of dam, was the limiting consideration.

Since a large spillway-flow depth was desired—for safety margin above all flood forecasts—the heights above spillway crest were worked out on a uniform basis. To this end an imaginary flood runoff of 14 in. in three days, which is no less than twice as large as that of 1913, was assumed; with spillway lengths determined by other considerations, the overflow depth was computed (the conduit discharge continuing at the same time). This gave depths ranging from 10 ft. at some of the dams to 14 ft. at others. A uniform freeboard of 5 ft. above this imaginary water level was then adopted, which fixed the dam-crest elevations.

With respect to the proportioning and methods of construction of the dams, the existence of some popular prejudices against dams—and especially against earth dams—was held to justify excessive safety provision.

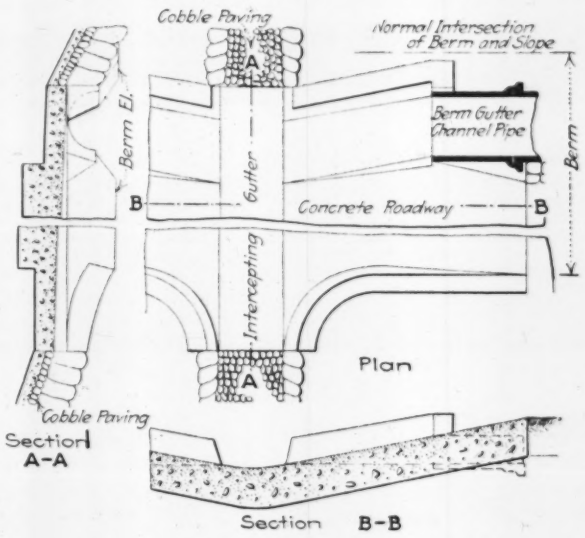
The fears were concerned partly with the fact that the dams would be dry for years and then might suddenly be exposed to full service, with maximum head of water stored in the basins, for periods of one to three weeks (the Englewood basin, which has the highest dam and for its storage the smallest conduits, will take three weeks to empty after the assumed maximum flood). Although there was virtually no direct experience on this subject that could be quoted, the engineers were at all times convinced that the dry dams would be *far safer* than dams that are constantly wet and exposed to percolation under head.

The soil in the valley and on the adjacent upland is glacial till, comprising gravel, sand and clay in varying proportions. Prospecting and sampling proved that tight mixtures were either naturally available or could be put together. This fact was verified carefully, by analyses of grain size and by the expert judgment of men long engaged in earth-dam construction. It simplified the questions of foundation and of dam design quite materially.

No Core Wall or Lining; Cutoff Trench Used

Construction of an embankment by either roller compacting (in layers) or by hydraulic deposition was decided to meet all requirements, without lining or core wall. A cutoff trench to go down 30 ft. or so, well below the surface layers, will be used.

The section adopted, Fig. 2, is distinctly more ample than that of the latest and strongest existing dams on tight or semipermeable foundations—though, of course, not comparable with the Wachusett or Gatun type. It is proportioned for specially wide base. The features are



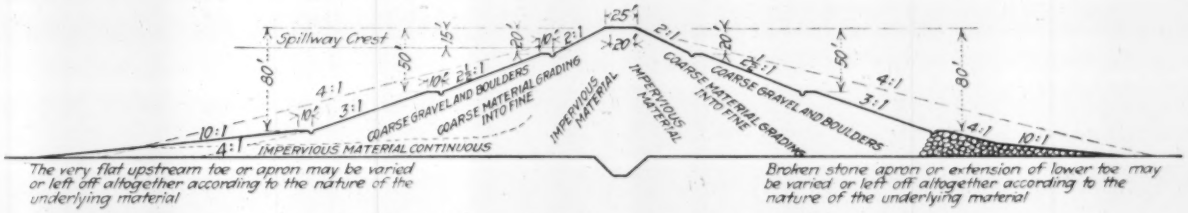

Spillway Crest
80'
50'
10'
4:1
3:1
2½:1
2:1
10:1
COARSE GRAVEL AND BOULDERS
COARSE MATERIAL GRADING INTO FINE
IMPERVIOUS MATERIAL
IMPERVIOUS MATERIAL CONTINUOUS
The very flat upstream toe or apron may be varied or left off altogether according to the nature of the underlying material
Broken stone apron or extension of lower toe may be varied or left off altogether according to the nature of the underlying material

FIG. 2. TYPICAL CROSS-SECTION OF MIAMI CONSERVANCY DAMS
With detail of berm and gutter shown above

frequent berms, concaved sides and symmetrical outline—that is, upstream and downstream faces alike (because these are dry dams). Compared with the standard embankments of the Board of Water Supply of New York City, the upper berm is nearer the top and the slopes flatten out more toward the bottom, to a maximum of 4 to 1. Toe protection of broken stone sloped 10 to 1, as shown in the sketch, may be added if found convenient or desirable.

The slopes are to be grassed, top soil being placed on the structural body of the embankment for this purpose. It is intended that they shall be kept trimmed and neat at all times after construction, as part of the regular maintenance work of the district.

Slope drainage (for surface water) is accomplished by paved berm gutters and connecting gutters down the slopes. The chance of deterioration from settlement or any other cause is held to be vanishingly small with gutters, as compared with buried pipes.

The cutoff trench is indicated in Fig. 2, although local conditions will determine its depth. It is intended mainly to give most intimate connection between the impervious dam core and the subsoil, and thereby prevent seepage along the base. In all cases the dams will be built on ground stripped of top soil. The subsoil contains very little bedded porous material, so far as the borings and test pits revealed; in the process of making wash borings, the pipe lost its water only rarely. Geological indications are that any porous deposits are local—that is, have little horizontal extent. It is also important to recall that underwashing of a dam is a slow process, while here the water will never stand behind the dam more than a short time.

At the Huffman dam, in Mad River Valley, the most porous ground was encountered (Fig. 5). For purposes of calculation this material was assumed to be as open as very coarse sand. Yet the computed velocity of outflow proved to be almost infinitesimally small ("five times the velocity of the long hand of a watch"), although the extreme case was taken of the outflow concentrated in a 3-ft. width at the toe of the dam.

It is believed that the dam body as shown by the section, with the materials available in the valley, will be permanently sound, and proof against accidental or malicious injury as well as against deterioration.

The vital element of these dams lies in the outlet conduits. They must always be open, or the retarding basins lose some of their protective power. They must be struc-

turally sound, or the high discharge velocities might tear them to pieces and wash out the dam. Straight flow-lines and smooth, durable surfaces must be obtained. The Germantown and Englewood conduits must carry the weight of 120 ft. of earth above, without cracking or deforming, even when slight settlement or shrinkage of the embankment takes place. They must be bonded tightly into the embankment, so that water cannot flow along the outside of the walls.

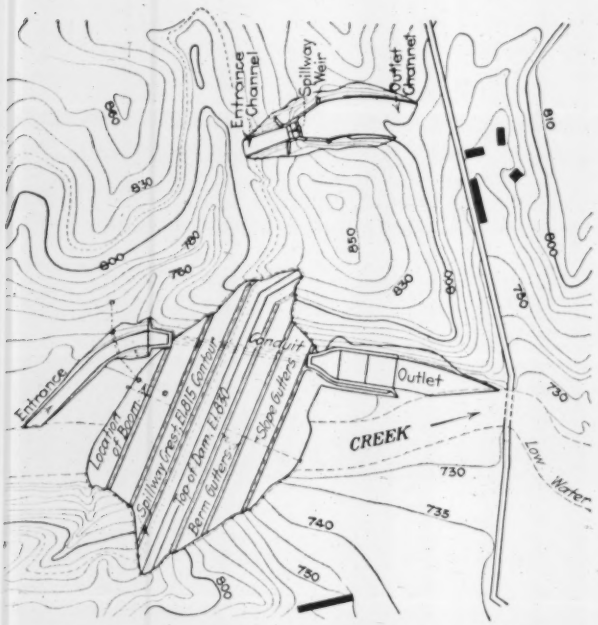


FIG. 3. PLAN OF GERMANTOWN DAM, SHOWING SEPARATE SPILLWAY

The prime importance of open outlets made it desirable to employ two (or more) conduits rather than one. If surface wear of the interior requires relining or the like, one conduit at a time can be taken in hand without endangering the operation of the system.

Separation of conduits and spillways (Fig. 3) was attempted in all cases, at first. The advantage of a spillway built in natural ground was considered decisive, while the conduits could not well be tunneled through the hillsides, but had to pass under the embankment. On further study, however, especially with regard to construction procedure, it was found that a combined outlet-and-spillway structure located within the embankment possesses marked superiority, at least for low dams. Such a structure solves the problem of stream control while the embankment is being carried up. For this reason the Taylorsville, Huffman and Lockington dams were provided with combined structures. At the two high dams, Germantown and Englewood, the separated spillway and conduits were found to be more practicable and economical.

The plans, Figs. 3 and 4, represent the two types—the separated structures of Germantown dam and the combined structure of Huffman dam. The difference of length of conduits should be noticed in Table 1, 725 ft. against 40 ft. Since the friction loss in the long conduits amounts to more than 10 ft. of head, the longer conduits must be appreciably larger—and therefore more costly—to secure the desired discharge capacity. Further, the long conduits involve more complication in the way of transverse joints, cutoffs, etc., and structurally present more difficult problems of design. On the other hand, with a combined structure the retaining walls that form the spillway abutments become enormously expensive when a height of 100 ft. is approached, as at Germantown and Englewood.

The proposed construction procedure is to build first the concrete trough formed by conduit floor and spillway abutments, leaving out the spillway and conduits. This trough forms an ample stream channel, through which the river is diverted. Construction of the dam then proceeds under safe conditions. Finally the concrete trough is bulkheaded off so that the conduit division walls can be concreted. As the last step, the spillway body is built, this work lying well above normal stream level. Deep notching of spillway into side walls will take care of downstream thrust of impounded water.

Cross-sections of the conduits are given in Figs. 6 and 7. For the combined structures, substantially rect-

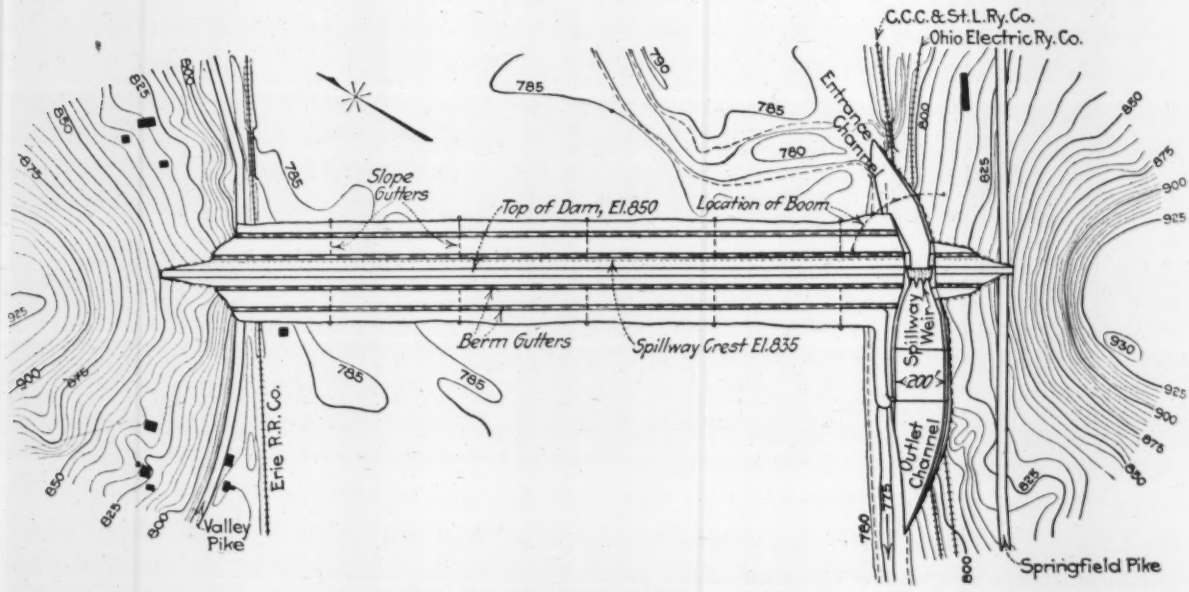


FIG. 4. PLAN OF HUFFMAN DAM, WITH COMBINED SPILLWAY AND CONDUITS

angular sections were adopted, while the separate conduits are of horseshoe shape. A rich lining is to be used—a 1:1½:2½ concrete placed in the forms integral with the body—for resistance to abrasion. Whether hard-brick facing of the invert will be used is not decided. Table 1 shows the maximum conduit velocities in cases of great floods. These velocities are high, but not as high as in the case of several other structures where concrete conduit linings are giving perfect satisfaction. At Arrowrock dam, for instance, the concrete outlets have been subjected to velocities as high as 70 ft. per sec. for several weeks at a time during the last two years, and to velocities above 60 ft. per sec. for much longer periods, with no indication that the concrete lining will not remain in good condition indefinitely (Charles H. Paul). Many other instances are on record where carefully constructed concrete linings are withstanding velocities as high as 60 ft. per sec. with no signs of wear. And in practically all these cases the periods of high velocity are much more frequent and much longer than will be the case with these.

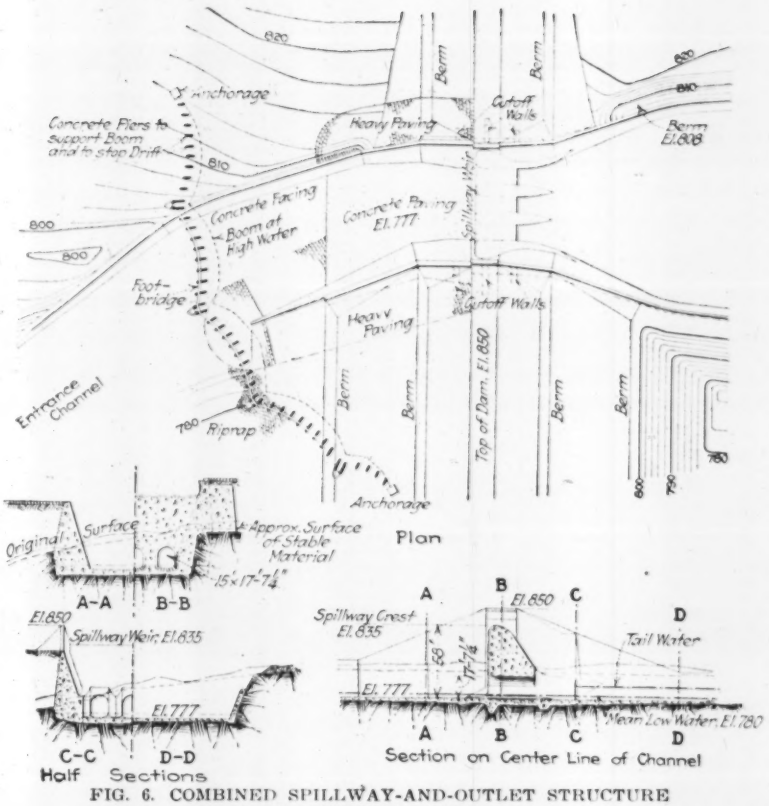


FIG. 6. COMBINED SPILLWAY-AND-OUTLET STRUCTURE OF HUFFMAN DAM

TABLE 1. DISCHARGE-CONDUIT VELOCITIES

	With Ultimate Maximum Flood, Ft. per Sec.	At 14-In. Flood, Water 5 Ft. Below Dam Crest, Ft. per Sec.	Length of Conduits, Ft.
Germantown	55	59	520
Englewood	56	60	725
Lockington	56	61	45
Taylorsville	48	57	40
Huffman	50	59	40

The entrance end of the conduits is flared or belled out slightly, to avoid throttling under full flow. Above here the entrance channel is tapered smoothly, for good approach, and beyond the concrete approach platform the earth surfaces of channel and embankment are paved with

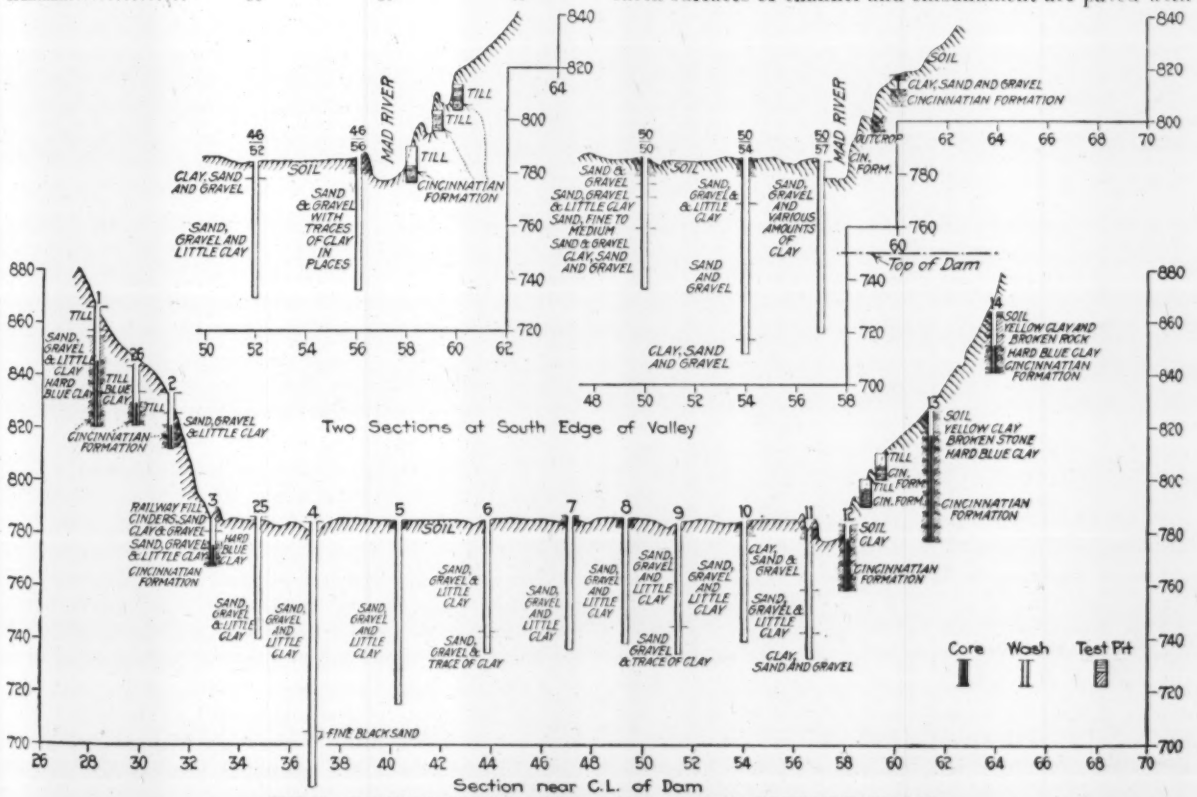

Two Sections at South Edge of Valley
Section near C.L. of Dam
MAD RIVER
TILL
CINCINNATIAN FORMATION
SOIL
CLAY, SAND AND GRAVEL
SAND, GRAVEL AND LITTLE CLAY
SAND & GRAVEL WITH TRACES OF CLAY IN PLACES
SAND & GRAVEL
SAND, GRAVEL & LITTLE CLAY
SAND, FINE TO MEDIUM
CLAY, SAND AND GRAVEL
SAND, GRAVEL AND VARIOUS AMOUNTS OF CLAY
SAND AND GRAVEL
Top of Dam
SOIL YELLOW CLAY AND BROKEN ROCK HARD BLUE CLAY
SOIL YELLOW CLAY BROKEN STONE HARD BLUE CLAY
SOIL CLAY
CIN. FORM.
RAILWAY FILL CINDERS, SAND CLAY & GRAVEL SAND, GRAVEL & LITTLE CLAY
HARD BLUE CLAY
TILL BLUE CLAY
SAND, GRAVEL & LITTLE CLAY
SAND & TRACE OF CLAY
FINE BLACK SAND
Core
Wash
Test Pit

FIG. 5. SECTION OF MAD RIVER VALLEY AT HUFFMAN DAM SITE

stone to prevent erosion. At the lower end, the conduits open out on a discharge channel, a remarkable structure of critical importance, whose development by experiment is noted farther on. Belling the outlet ends of the conduits was considered, but rejected.

The long conduits presented various structural problems. They carry over 100 ft. of fill at midlength and not more than 10 or 15 ft. near the ends. In some cases the rock on which they will be founded may be capable of taking only comparatively low bearing pressures with safety; and although no settlement is anticipated, it was thought advisable so to design the structure that it would accommodate itself to slight settlement, if necessary. The questions of stress distribution and arch action needed study, therefore.

The foundation rock, the Cincinnatian formation, varies considerably in load capacity, depending on whether the clay layers are already consolidated to shale or remain of clay nature. In the latter case the allowed loading will be limited to what hard, confined clay can carry. There will be no serious difficulty in designing to this limitation. The strata all are horizontal, although the rock surface (probably formed by glacial erosion) goes down sharply from the valley sides to great depths—well over 100 ft. at most of the sites (see Huffman site section, Fig. 5).

A factor in the structural design was the desire to avoid the use of steel reinforcement above low-water level. The conduit walls and arch were therefore designed of mass section. The floor was at first planned out as a plain arch invert. With footing pressures limited to 7 tons and a load of 64 tons per lin.ft. of wall (at Englewood), the floor must distribute the wall loads of a single conduit over 18 ft. of width. To do this in reliable manner by

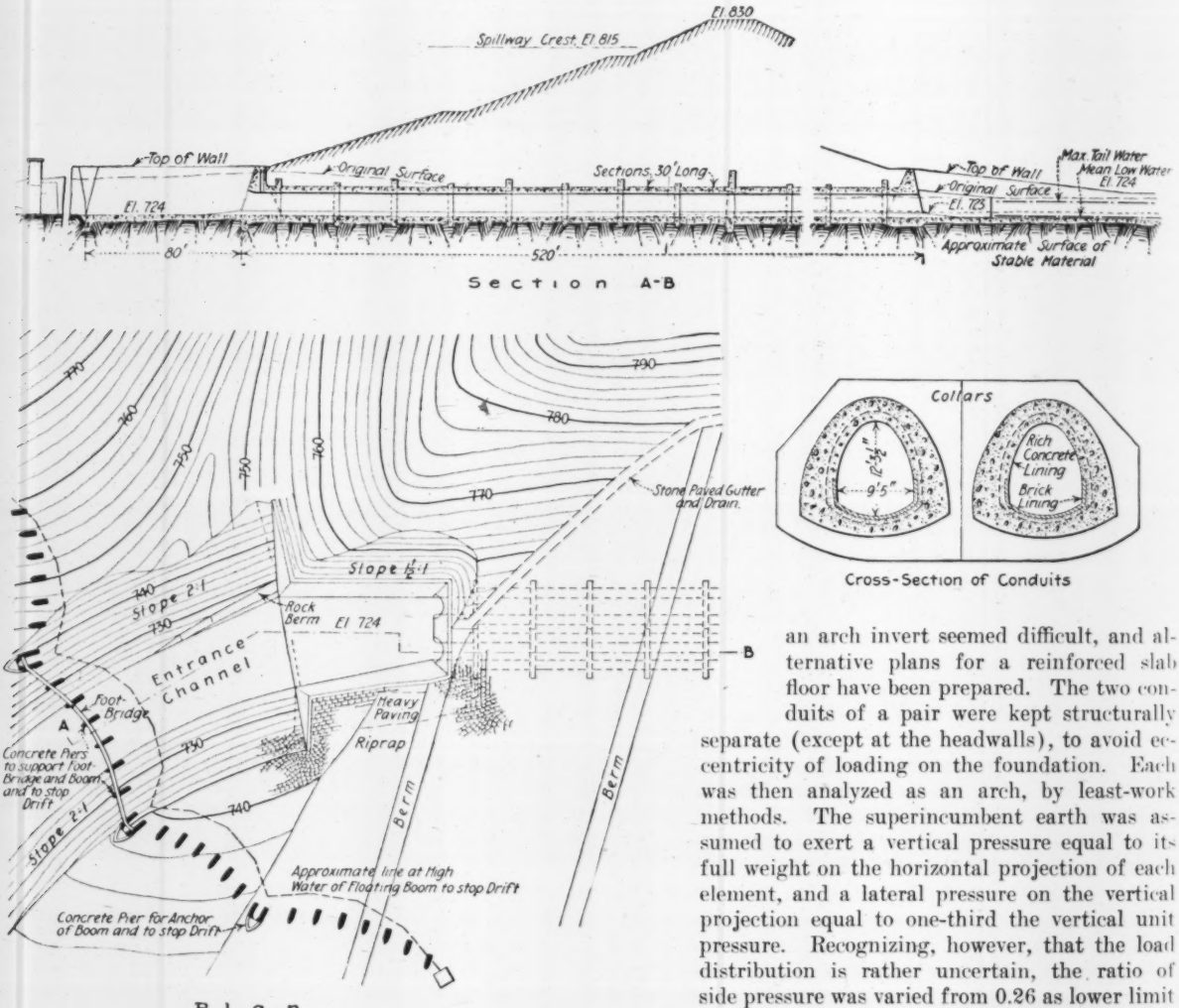


FIG. 7. GERMANTOWN OUTLET CONDUITS
Plan, profile and cross-section of conduits

an arch invert seemed difficult, and alternative plans for a reinforced slab floor have been prepared. The two conduits of a pair were kept structurally separate (except at the headwalls), to avoid eccentricity of loading on the foundation. Each was then analyzed as an arch, by least-work methods. The superincumbent earth was assumed to exert a vertical pressure equal to its full weight on the horizontal projection of each element, and a lateral pressure on the vertical projection equal to one-third the vertical unit pressure. Recognizing, however, that the load distribution is rather uncertain, the ratio of side pressure was varied from 0.26 as lower limit to 0.40 as upper limit, and the pressure line was kept in such a range of position that the unit stresses in the concrete would never exceed the allowed pressures by more than 20% due to change in ratio.

With regard to compressibility of the foundation strata and temperature stresses, the conduit arch is to be made virtually three-hinged, by placing construction joints at bottom of side walls and at crown. Interposition of a thin cushion layer—as asbestos felt—in these joints is expected to insure perfect adjustment of the arch to its load and to temperature variation. Without the three-hinged arrangement the computed temperature stresses were serious (up to 250 lb. per sq.in.).

The structural calculations were made for two thicknesses of wall—that is, with and without the lining layer. This will insure safe stability even during a period of repair, when, for example, the lining might be cut out for replacement.

Longitudinal shrinkage is taken care of by building the conduits in 30-ft. sections. These are to be laid up concrete against concrete and are not intended to give room for expansion, as it is expected that the work will

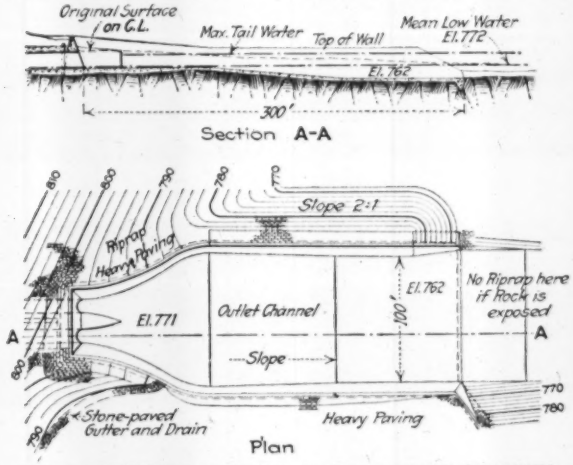


FIG. 8. ORIGINAL DESIGN OF DISCHARGE CHANNEL

be carried out in summer temperatures. Each length has a 3-ft. cutoff collar at one end, integrally formed. Larger collars (6 to 8 ft. wide radially) will be placed at the center of the dam.

The water spouting from the conduits at great velocity (see Table 1) must be brought down to not over 6 to 8 ft. per sec. before it can be discharged into a natural channel. The assumption was made that 12 ft. per sec. is a maximum for flow over riprap. Of the possible means for destroying the energy stored in the spouting water and bringing its velocity down to the limit indicated, the hydraulic jump or standing wave was chosen as best. It was known that the jump would result automatically in any event and would be fairly straight and regular if the discharge were flattened down to a thin, wide sheet. But unusual conditions had to be provided for, in the form of very high initial velocity at full head in the basin, variable velocity during filling or emptying of the basin, and concentration of the discharge in several separated jets—one from each conduit. Under these conditions there might be such irregularity in the line of the jump and such variation in its position as to require an unduly long concrete channel, which was bound to be very costly. Experiments were undertaken to develop a form of channel that would regularize and stabilize the jump, so that a short discharge channel would suffice. Two long series of experiments were made, on a linear scale of one-sixteenth and a velocity scale of one-fourth full size (one-fourth because $\frac{1}{4}$ v is proportional to $\sqrt{\frac{1}{16}h}$). They were made on the farm of E. A. Deeds, chairman of the Board of Directors of the Conservancy District. A small lake furnished convenient opportunity for water-supply and discharge. A large centrifugal pump, forcing water through two pipes about 6x9 in. each, and a wooden flume 10 ft. wide by 26 ft. long by 3 ft. deep, within which various forms of wooden discharge channel could be built up, constituted the apparatus (see Fig. 1).

The first series showed that a 10% down-slope in the channel, following a smoothly curved widening, would develop a good uniform sheet, near the foot of which the jump would occur. The discharge channel designed in the early part of 1915, shown by Fig. 8, was based on these experiments.

Jump Stabilized by Steps and Tailwater Weirs

Still greater stability and regularity seemed desirable, however, especially to avoid local high-velocity currents in part of the width at the delivery end of the channel. An elaborate set of experiments on the effect of obstructions in the channel was therefore undertaken. It was believed that such obstructions would localize the jump in reliable manner. The belief was verified by the experiments.

The two principal elements of variation tried out in these experiments were: (1) Weirs in the channel just beyond the jump, to control the level of tailwater; (2) irregularities or roughnesses in the bottom of the sloped

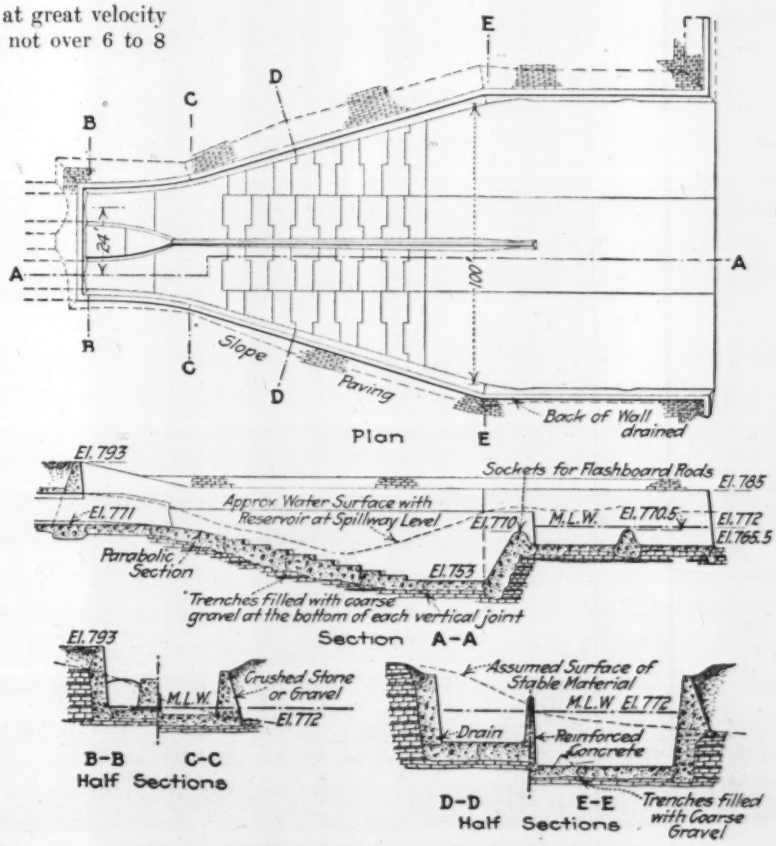


FIG. 9. FINAL DESIGN OF DISCHARGE CHANNEL

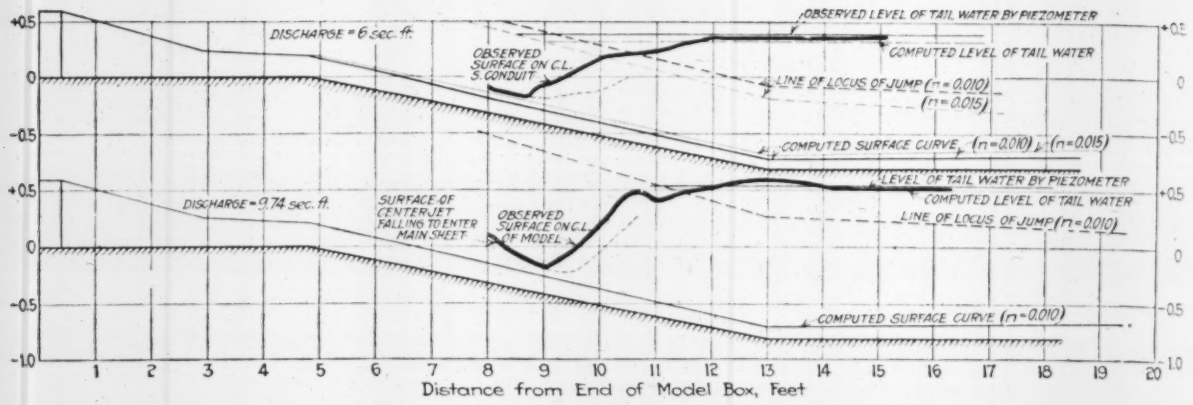

OBSERVED LEVEL OF TAIL WATER BY PIEZOMETER
DISCHARGE = 6 sec. ft.
OBSERVED SURFACE ON C.L. S. CONDUIT
COMPUTED LEVEL OF TAIL WATER
LINE OF LOCUS OF JUMP (n = 0.010)
(n = 0.015)
COMPUTED SURFACE CURVE (n=0.010) (n=0.015)
LEVEL OF TAIL WATER BY PIEZOMETER
DISCHARGE = 9.74 sec. ft.
SURFACE OF CENTER JET FALLING TO ENTER MAIN SHEET
OBSERVED SURFACE ON C.L. OF MODEL
COMPUTED LEVEL OF TAIL WATER
LINE OF LOCUS OF JUMP (n=0.010)
COMPUTED SURFACE CURVE (n=0.010)
+0.5
0
-0.5
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Distance from End of Model Box, Feet

FIG. 10. PROFILE OF JUMP, FROM ONE OF THE EXPERIMENTS

channel, to produce more equal lateral distribution of velocities in the water approaching the jump; and (3) division walls to separate the several conduit jets, extending for various distances, to a maximum where the end was well beyond the jump.

It was early found that a 15% slope in the channel was better than a 10% slope. Some of the further conclusions from the experiments are as follows:

The jump begins above the computed position and ends below it, the latter point being indefinite.

When the water can be made to enter the jump in a sheet of uniform thickness and velocity across the channel, the jump is stable; that is, it is uniform across the channel, and the tailwater moves away without great excess of velocity at any point. The side wall must not be concave toward the water until the jump is passed.

A nonuniform sheet tends to produce an unstable condition of the jump, causing the flow below to be concentrated at high velocity on one side of the channel. Stability is secured by the use of one or more submerged weirs below the jump. The weirs must not be placed close enough to the jump to interfere with its normal formation.

When the flow from one conduit is materially diminished, a high weir is necessary, the most satisfactory height being about one-half the depth of the tailwater at maximum discharge. The addition of a second weir below tends to increase the stability of the jump and to improve the distribution of flow below.

The inclined portion of the channel above the jump may be shortened and steepened indefinitely, provided that the floor be not below the parabolic path of the water issuing as a jet and that sufficient length be provided to permit the water to spread so as to develop a thin and nearly uniform sheet.

Roughening the inclined portion of the channel floor with steps or other equivalent means checks the velocity by increased friction and increases the stability of the jump.

Three views of the jump as realized in the experiments are given in Figs. 11 to 13. A sketch of the profile of the jump in two cases is reproduced in Fig. 10.

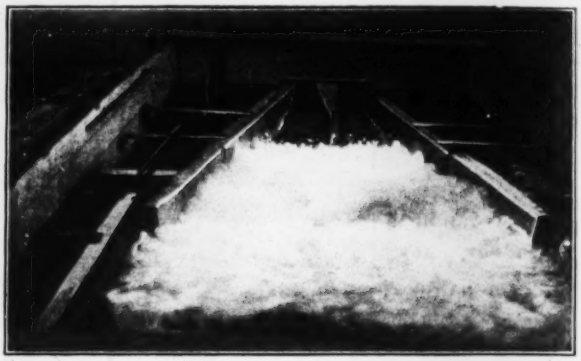
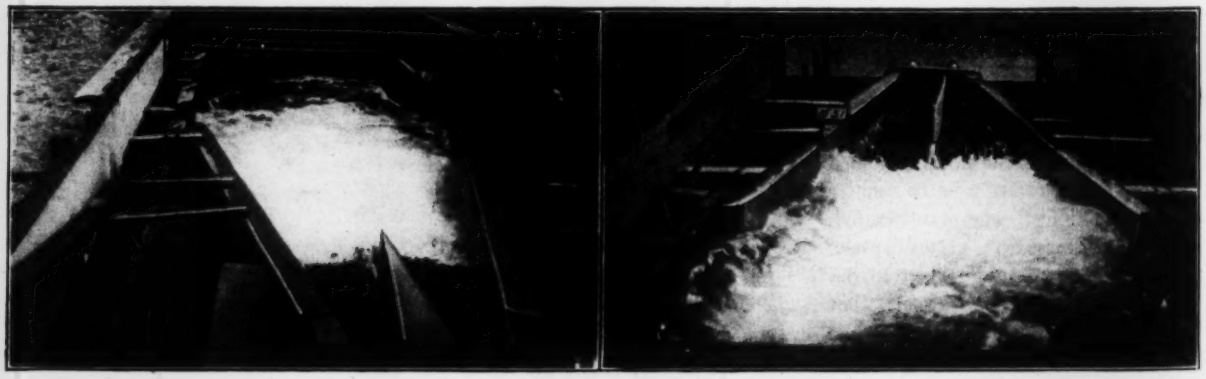


FIG. 13. JUMP WITH 6-IN. WEIR 1 FT. BELOW FOOT OF SLOPE; DISCHARGE 9.74 SEC.-FT.

These experiments furnished the basis for the complete detailed design of the discharge channel. The final result is given by the drawing, Fig. 9. It includes the stepped slope, the pair of submerged weirs and the dividing wall to a point beyond the jump.

The discharge channels will all be founded directly on rock (Cincinnatian formation), and will have a substantial thickness of concrete floor. It will be necessary to construct this floor in separate blocks, on account of its size; but care will be taken to avoid any large grooves or openings between the blocks, where the high-velocity eddies of the discharge might get a hold for destructive action.

Protecting the conduit entrances against drift was not as serious as might be supposed without an analysis of the situation. Floods large enough to pick up any drift of



FIGS. 11 AND 12. SMOOTH CHANNEL AND SYMMETRICAL FLOW; DISCHARGE 9.74 SEC.-FT.

troublesome size would quickly submerge the conduit openings. Drift that enters the basin or is picked up by the rising waters after a small pond had been formed would be moved only very slowly by the current, but its movement would be controlled largely by the wind. Even should it reach the vicinity of the conduit inlet, it would

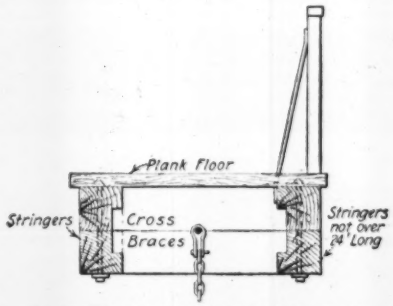


FIG. 14. SECTION OF FLOATING BOOM FOR DRIFT

either pass straight through or float harmlessly on the surface. With the designs of inlet adopted the possibility of clogging would be exceedingly remote.

Because of popular doubts on the subject, however, and also because drift barriers could be constructed at small cost, it was decided to provide further protection by a series of concrete piers spaced 10 ft. apart in the clear, rising nearly to spillway-crest level, and a floating boom. Large pieces of drift—trees, telegraph poles or even houses—would be held back by the piers. Smaller floating material would be held back by the boom.

The boom is anchored at intervals to heavy abutment piers and normally rests on top of the intermediate piers. The boom design reproduced by Fig. 14 was included in the Official Plan, but this may be improved before construction is started; it is regarded as adequate, but not necessarily the most practical form of construction.

The boom is normally about 30 ft. above top of conduits. Its channel portion hangs rather low and may be within reach of one-year or two-year floods, although these are expected to go through most of the basins without detention.

Kenneth C. Grant had charge of studies of action of retarding basins during floods and directed the preparation of practically all the tables and diagrams referred to in this article; A. B. Mayhew made numerous studies of balancing various reservoirs in a harmonious system; Barton M. Jones developed general method for determining requisite spillway capacities for any set of conditions.

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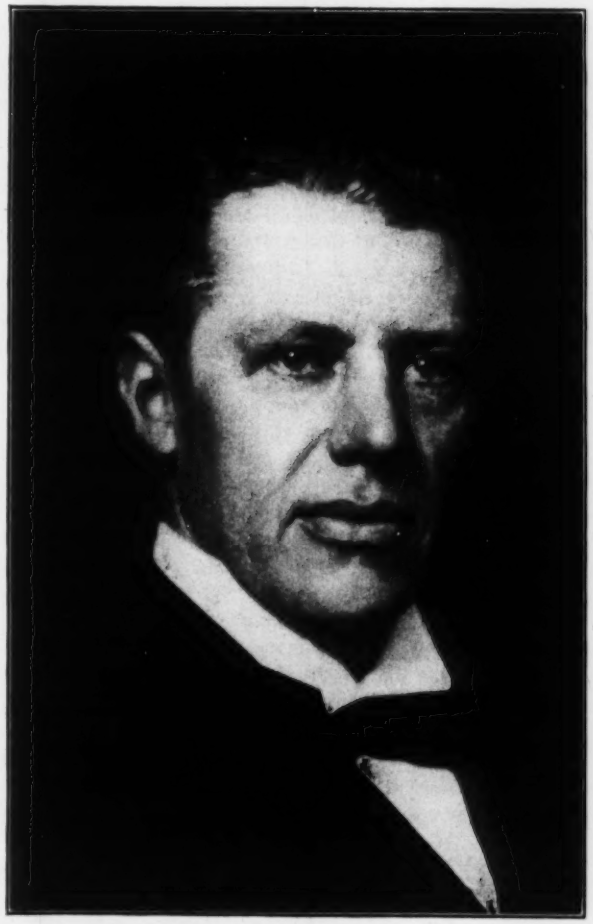
H. G. Stott's Part in New York City's Rapid-Transit Development

Henry Gordon Stott, whose death on Jan. 15 was noted in *Engineering News* of Jan. 18, had a very important part in the development of New York City's rapid-transit system. This part was the supervision of the design, construction and operation of the great electric-power generating plants that energize the whole system of subway, surface and elevated railways in the greater city.

The post to which Mr. Stott was called in 1901—Superintendent of Motive Power of the Manhattan Railway Co.—had just been created; and it devolved upon him to organize the operating force, in connection with which he completed the 74th St. power plant of the company, various substations and transmission lines. When the Manhattan system was amalgamated with the Interborough in 1904, he took over supervision of the construction of the power plant on 59th St. Since that time he had been constantly in charge of design, construction and operation of the power-generating stations and the distributing system of the Interborough Rapid Transit Co. and the New York Railways Co. The plans for the electric-power system of the new subway lines have been developed under his supervision, and the work has progressed so far and bears so strongly the stamp of his work that, when completed, it will be a monument to him.

His engineering activities included most whole-hearted and conscientious service in three of the great national engineering societies, as President of the American Institute of Electrical Engineers, as a Vice-President of the American Society of Mechanical Engineers, as a Director



H. G. Stott

of the American Society of Civil Engineers and as Vice-President and Trustee of the United Engineering Society. In the American Institute of Electrical Engineers Mr. Stott was a member of the Standards Committee, the Committee on Development of Water Power, the United States National Committee of the International Electro-technical Commission, the Power-Stations Committee, the Committee on Economics of Electric Service and was on the Joint Committee on the Metric System, of which he was an ardent advocate.

Notes from Field and Office

Heavy trucks hauled out of excavation by way of two inclines—Non-calculus solution proposed for the sphere segment problem—Derricks for unloading cars—A simple hook gage

Hoisting Engine Snatches Wagons from Deep Excavation

The huge excavation for the Pennsylvania Hotel, opposite the Pennsylvania R.R. terminal on Seventh Ave., New York City, is 75% complete. The site is about 400x200 ft. in plan. The depth of excavation is 35 ft. below the street level and is principally in Manhattan schist. The yardage is 100,000. Already 40 column footings have been put in, and the excavation is going forward at the rate of 300 yd. per day. The rock is drilled and shot, loaded by hand into skips, which are lifted by derrick and dumped into elevated hoppers conveniently placed. Both teams and motor trucks haul the spoil out of the excavation and to the dump. A revolving steam shovel at the east end loads directly into trucks.

On each side of the site is one of the Long Island R.R. tunnels; the tunnel on the north side is almost entirely within the building site. The excavation has already uncovered this tunnel, the roof of which serves as a roadway for the trucks and wagons.

The spoil is hauled out by way of two inclines—one rising from subgrade to the roof of the north tunnel, the other rising from this intermediate level to the street, as shown in the accompanying sketch. The lower incline is about 70 ft. long; the other is 150 ft. An electric hoist installed under the head of each incline snatches the loads out of the pit. The wagons and trucks are moved smoothly, the delays being brief.

From the top of the shorter incline the motor truck continues to the foot of the second incline, where it stops to have two steel cables hooked to steel eyes fastened on each side of the front of the chassis. Rings have been bolted on each side of the frame toward the rear, and a rope attached to the end of a stick is threaded through each of these rings, the other end of the rope being held by men who walk up the incline behind the truck. The stick is for blocking the rear wheels in the event of the cables snapping or the hoisting power going off. Only the motor trucks are protected in this manner (Fig. 1), the wagons depending for safety upon the teamster, the handbrake and the horses.

The empties are safely retarded in going down, by a line attached to a ring at the rear of the wagon. This

FIG. 2. LOOKING WEST TOWARD LONG INCLINE FROM TUNNEL ROOF TO STREET

serves another purpose than preventing runaways, as it also returns the line to the foot of the incline, so that it may be attached to the next outgoing vehicle.

The trucks and wagons drive under one of the two elevated hoppers shown in the sketch and are loaded through a trap. After shooting, the rock is placed by hand in large skips or in dump buckets, which are lifted by the nearest derrick, and dumped into the hoppers. One of these hoppers is built on the tunnel roof. After a wagon is

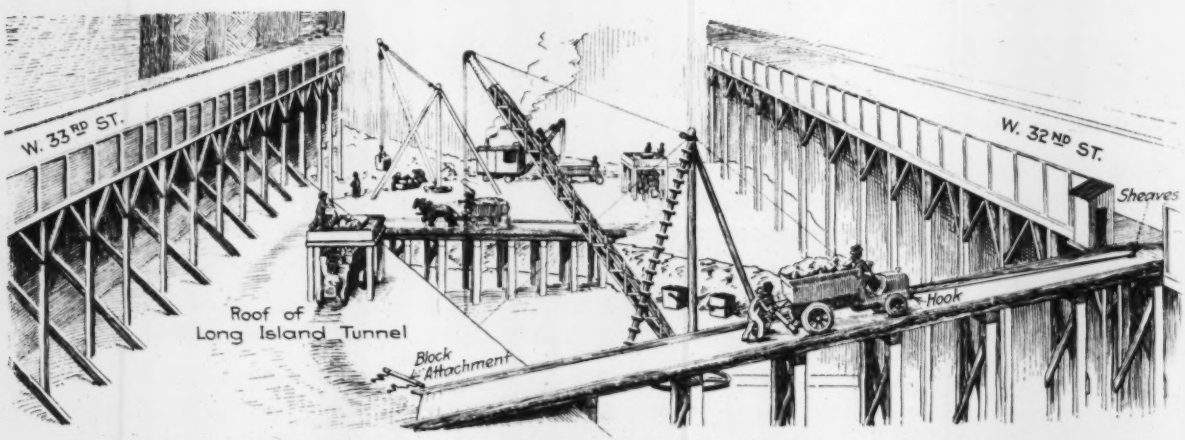


FIG. 1. HANDLING ROCK AT SITE OF PENNSYLVANIA HOTEL, NEW YORK CITY

loaded here, it is given a start by a snatch team of three horses. The trucks are able to start under their own power.

The George A. Fuller Co. is the general contractor. The hauling contractor is Jacob Fradus.

An Elementary Solution Proposed for the Sphere Segment Problem

The interesting sphere segment problem discussed by various readers in our issue of Mar. 16, 1916, p. 518, is revived by Austin K. Wardwell (Cambridge, Mass.), who proposes an exact *non-calculus* method of solution.

The problem is to find the volume of the part segment whose front half is shown heavily outlined in Fig. 2, given the radius of the sphere and the ordinates of the two bounding planes (which are at right angles). Mr. Wardwell's method of attack is to find the volume of the spherical cone swept out by a radius passed around the surface area PKL, and deduct from it the volumes of the two cones formed by radial elements passed around the two plane bases KMP and PML.

Since the plane segmental areas KMP and PML are readily computed, the method depends on the possibility of computing the surface area PKL. This computation is to be done as follows:

Describe great circle arcs XP and PZ. The spherical triangle ZPX has one side, ZX, equal to 90°; its side ZP is equal to ZT equal to ZL, which can be calculated; its angle X is measured by the subcircle arc PK; its angle Z is measured by the subcircle arc PL. Therefore the spherical triangle can be solved and its area determined.

Next considering the zone cut from the surface of the full sphere by the plane KPN, it is evident that the area

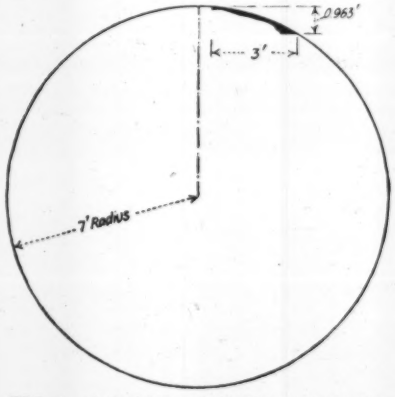


FIG. 1. SPHERE-SEGMENT PROBLEM

of the zone can be computed (equal to a meridian circumference of the sphere multiplied by the height of the zone) and that area KPX is a proportional part of this zone, measured by arc KP. This will give area KPX; by subtracting from ZPX the area ZPK is obtained.

Finally, the zone cut from the full sphere by plane PML is computed, and the sector ZPL is found as a proportional part of it, measured by the arc PL. Then, subtracting from ZPL the previously found area ZPK, the result is the desired surface area of the segment, or KPL.

The rest of the calculation is to multiply KPL by one-third of the radius, which gives the volume of the spherical cone O-KPL; multiply the plane area PML by one-third the altitude MN, and the plane area PMK by one-third the altitude MS, which gives the volumes of the oblique cones O-PML and O-PMK; and finally subtract the latter two volumes from the volume of the spherical cone.

In the original problem, the radius of the sphere was 7 ft., the width ML of the segment was 3 ft., and the

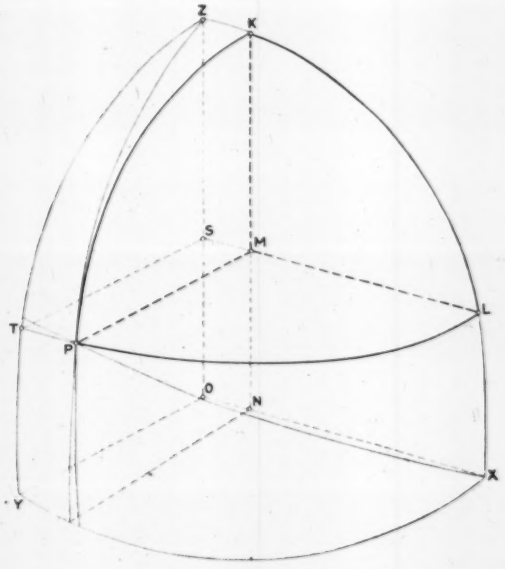


FIG. 2. CONSTRUCTION FOR ELEMENTARY SOLUTION OF SPHERE-SEGMENT PROBLEM

height MK was 0.963 ft. Applying to these figures the above method of calculation, Mr. Wardwell finds the volume (twice the volume shown in the sketch) to be 7.457. As a check, arithmetical calculation was used. First, the volume of the full segment cut off the solid sphere by plane $PLMS$ was found. Then the subtractive volume $PMKZST$ was computed by Simpson's formula, with three intermediate points between S and M. The full volume was 10.218, and the subtractive volume 2.762, giving the result 7.456.

This simple method may appeal to those who labored over the problem last year, especially those who struggled with the calculus solution and were not able to perform the integration.

Car Derricks for Handling Rails, Pipe and Timbers

Derricks and derrick-cars are used extensively by railways for loading and unloading rails at yards and on the track. Similar machines are used by railways, contractors and others for handling timbers, pipe, frogs and other heavy articles. Some of the machines described are on the market, but others are designed and built by railways for their own use.

For handling rails along the track, the New York Central R.R. uses steam locomotive cranes on main lines, but for side and branch lines it has air-hoist derrick-cars designed by its own staff and built at its shops at Corning, N. Y. One of these derrick cars is shown in Fig. 1. The machine is a 35-ft. flat-car, having at each

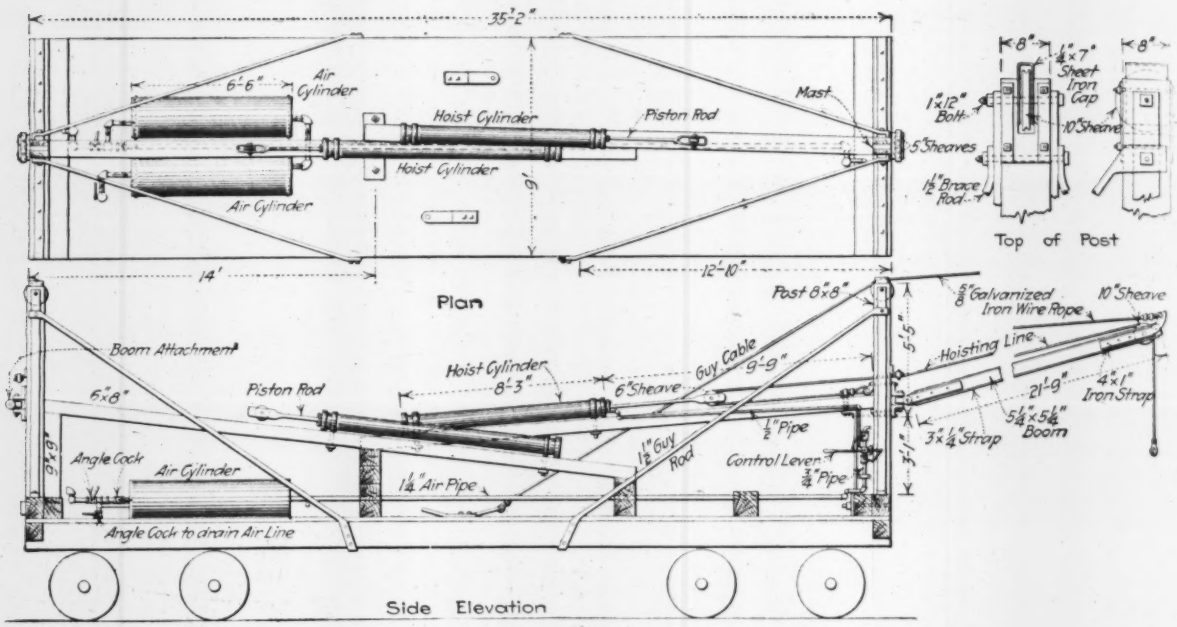


FIG. 1. RAIL-HANDLING DERRICK CAR FOR THE NEW YORK CENTRAL R.R.

end a mast 8½ ft. high. The mast is built up of two timbers kept apart by spacing blocks to permit the passage of the hoisting line between them. It is secured by brace rods bolted to the head of the mast and against the side sills of the car.

At about 3½ ft. from the floor the mast has an attachment for a boom, which is held a little above the horizontal position and can be swung laterally. The boom is about 22 ft. long and consists of a timber 5¼ in. square with an iron strap 3x¼ in. on top and bottom. The heel has a double swivel and the head has iron straps whose outer ends are bent up for the attachment of the guy line. The guy is a ⅝-in. wire rope passing over a sheave on the mast and having its ends fastened to the head of the boom and a lug on the floor of the car.

Behind each mast is an inclined timber carrying a 7½-in. air cylinder 8 ft. 3 in. long. The piston rod of this ends in a loop carrying a 6-in. sheave. The hoisting line, with one end anchored to the mast, leads back to the sheave, from which it returns to pass through the mast and between a pair of 5-in. horizontal guide sheaves, and out to the 10-in. sheave on the head of the boom. For each operating cylinder there is an air storage cylinder or receiver, with connections to the train-brake air-line, and all movements are controlled by a lever and valve mounted behind the mast, in convenient position for the operator. Information as to this device has been furnished by A. M. Clough, Supervisor of Track, Batavia, N. Y.

A Travis rail-loading machine was designed on the Fort Worth & Denver City Ry.; particulars of this have been given by R. C. Gowdy, Chief Engineer. The derrick was originally made portable, so as to travel along the flat cars in the same way as a ditching machine. This caused trouble, however, and the machine as now operated is mounted as a stationary derrick on a 43-ft. car. The original plan also provided for a mast and 20-ft. boom on each, but in later work one of these was removed and the other mounted at the middle of the derrick frame. The hoisting cable is operated by drums driven from a gasoline engine.

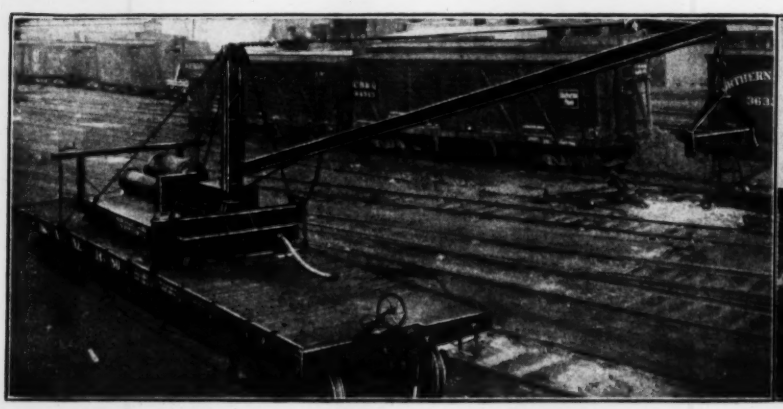


FIG. 2. PORTABLE RAIL-HANDLING DERRICK MOUNTED ON A FLAT CAR

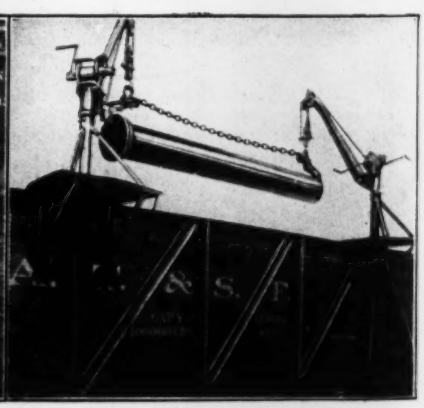


FIG. 3. LIGHT HAND DERRICK FITTED TO GONDOLA CAR

While the machine probably could be developed so as to be more efficient, the experience on this road has been that for handling small amounts of rail an ordinary derrick (provided with rail clamps) is faster, can be operated with fewer men, and is generally more satisfactory. The moving of the machine from car to car is not considered of much advantage, as ordinarily it is necessary to run the work train to a siding to get clear of regular trains before an entire carload of rails is picked up, and it is an easy matter to switch the derrick-car at that time. However, on roads of heavy traffic it might be very desirable to avoid this switching and rearranging of the work train.

The American rail-loader, shown in Fig. 2, consists of a four-wheel truck with mast and boom, all of steel construction. It has flat-tired wheels to travel along the floor of the car (flat or gondola), steel channels being provided as bridges to span the openings between cars. The hoist is operated by a compressed-air cylinder on the floor of the truck, and beside this is mounted an air reservoir. Flexible hose is provided for connection with the train pipe, as shown. This machine is built by the United Supply Manufacturing Co., of Chicago.

The Laas machine, built by the Chicago, Milwaukee & St. Paul Ry., was similar to this, but had the air cylinder on the boom. The Ware machine for unloading rails from gondola cars consisted of a gallows frame seated in pockets hooked to the sides of the car, and having two air-hoist cylinders suspended from the crossbeam. There were no cables, but each piston rod carried rail tongs. The device simply lifted the rails so that they could be slid down skids at the rear of the car as the train moved ahead. This was designed by Henry Ware, of Springville, N. Y., while Roadmaster for the Buffalo, Rochester & Pittsburgh R.R.

A larger and more elaborate device is the Brown rail-handling machine, which is a box-car having at each end an A-frame and low mast, with 22-ft. removable boom. The hoisting cables are led over sheaves and attached to the piston rods of horizontal compressed-air cylinders. With this machine placed between two rail cars, both cars can be loaded or unloaded simultaneously with two gangs. Each gang consists of an operator and four laborers. This rail-handling car is used on a number of large roads on which rail renewals represent considerable tonnage. It is sold by James C. Barr, 84 State St., Boston, Mass.

A simple outfit adaptable to a variety of purposes consists of a light portable hand derrick which can be mounted on the side of a gondola car. One or two derricks are used, according to the weight to be handled. The boom is carried by a short steel mast attached to a platform for the operator, this being hooked onto the top of the side of the car and secured by chains and braces on the outside, as shown in Fig. 3. The ¼-in. cable is carried by a drum having two crank handles, the operator holding a handle in each hand. This derrick is built by the Taylor Portable Steel Derrick Co., of Chicago. It is used by railways and contractors, the former employing it particularly for handling cast-iron pipe, large timbers and other heavy freight.

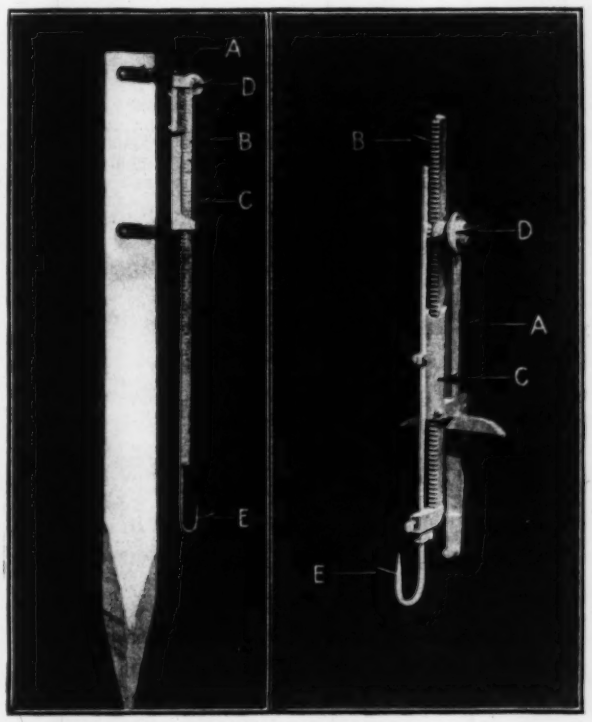
The boom (with drum) weighs 128 lb. and is detachable, having a cylindrical stem that fits within the hollow mast or post, which latter weighs 100 lb. The fixed reach is 3 ft. 4 in., and the height is 5 ft. from base of mast to hoisting block. The platform weighs 300 lb. including the chains and turnbuckles for securing it to the car. The cable can be rigged as a single, double or three-part tackle, to give increased capacity at lower speed. This derrick can be set up and removed very quickly. It is adapted for use at material yards and on construction work.

Convenient Form of Hook Gage

By R. B. Sleight*

The hook gage illustrated was developed by E. J. Hoff, of the Office of Public Roads and Rural Engineering, and has been in use by the engineers of the Division of Irrigation Investigations of that office for several years.

The instrument is made entirely of noncorrosive metal having a low coefficient of expansion. It consists essentially of the frame casting *A*, the rack *B* held in place



FIGS. 1 AND 2. HOFF HOOK GAGE OF THE OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING

by the spring *C* and actuated by the pinion *D*, and the hook *E* attached to this rack. Fig. 1 shows graduations of 0.01 ft. on the rack for 0.6 ft. This allows a movement of 0.5 ft. The vernier permits readings of 0.001 ft. The range of movement of the hook may be doubled or otherwise changed by sliding the bar up or down through the extended end of the rack, Fig. 2.

The instrument of Fig. 2 is designed for measurements of evaporation losses from tanks. The frame allows it to be set with three-point contact at a certain fixed datum on the rim of a tank or pan. It can be carried from place to place and relative measurements made without change for instrument correction or error. The gage of Fig. 1 is a type adapted to such uses as measurement

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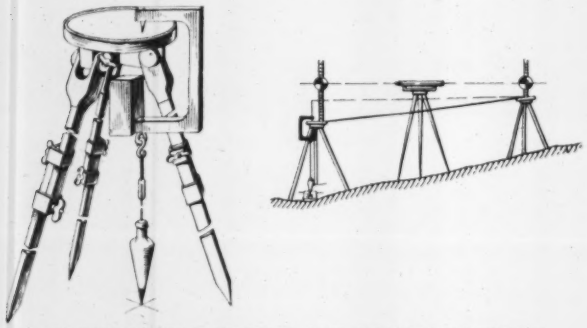
of head on a weir or canal elevations. It may be screwed to the weir box or stake, and by level and rod easily referred to any datum. When the rack is flush with the top of the frame, similar to the setting shown, the scale reading is zero. Therefore, scale readings may be used directly with rod readings taken from the top of the frame.

Some of the many good points of this little instrument are light weight, small size, portability, ease of adjustment and reading, and adaptability to various uses. It cannot warp or corrode under the action of water and air.

FINE AGGREGATE

Plumbing Instrument for Base-Line Work—The device illustrated is for reproducing a point from below to a point above, or vice versa, and is designed to be used in connection with base-line or other accurate tape measurements. It was devised in the Topographical Bureau, Borough of Queens, of which Charles U. Powell is Engineer in Charge. Distances are measured between points on the tops of small bronze tables mounted on steel extension tripods, the table tops being provided with white celluloid disks, on which the measurements are marked. The device consists of a cast-aluminum arm or bracket fitted with a steel pointer in the upper arm, and directly opposite it in the lower arm is a hook and eye for attaching the plumb line. It is held in perfect balance by a counterweight of lead incased in brass attached rigidly to



PLUMBING INSTRUMENT FOR BASE-LINE WORK

the lower arm, all parts made true and centered. In using, the instrument is brought directly over the point below by shifting on its pointer, and its position is marked above. As a test for error, the instrument is revolved 180° on its pointer. The instrument is designed to be carried in the pocket, its overall dimensions being about 4x6x1 in. and its weight 19 oz. A patent is pending. A center supporting rod with short sliding arm is set on the line of the table tops to overcome sag. Pluses are obtained with a steel tape and a plumb-bob. Eight men constitute a party, and from 8,000 to 10,000 ft. are measured in a day with an error not exceeding $^1/_{100000}$. A more detailed report on the making of the measurements was given in the Mar. 14, 1907, number of "Engineering News."

The Danger of an Exposed Flame in a city sewer tunnel was again demonstrated by an explosion, this time in St. Paul, Minn., on Nov. 29. About the only means generally taken of determining the presence of gas or gasoline vapor in sewers is by smell, which in this case was an unreliable means, as the conditions show. The 7x7-ft. sewer tunnel in which the explosion occurred is in sandstone, with a brick or granite-block invert 48 ft. below the street level, at the upper end, and on a 12% grade toward the river, where it has an outlet on a 5.65% grade. The explosion was caused by workmen who had erected a scaffold in a street manhole, which is 85 ft. deep, to repair the side walls at a point 35 ft. below the street level. Here four laterals 6x2½ ft. in size enter the manhole shaft. The men had lighted a candle and stepped from the scaffold into one of the laterals, when a blue flame circled about their feet and shot down the shaft. An explosion followed immediately, by which the scaffold was destroyed, but the men escaped unharmed. The explosion was felt for a block each side of the sewer, and several manhole covers were thrown upward. A sheet of flame and smoke was emitted from the outlet at the river. The explosion apparently was due to an accumulation of gases, probably gasoline vapor from garages and cleaning establishments. The workmen had noticed no odor of gasoline. It is probable that the lighter gases rising in the Third St. manhole acted as a fuse and ignited an explosive mixture of gasoline vapor and air in the tunnel below. The swinging gate at the sewer outlet was closed, as is customary in winter time, to shut off cold air currents. The catchbasins, which are untrapped, had also been shut off at their connection with the manholes in order to prevent the vapors of condensation rising from the sidewalk inlets on the street, for these are looked upon by the public as obnoxious from the fact that they come out of the sewers. The conditions were also very much aggravated by a heavy atmosphere outside. The tunnel was originally unlined; but as the softer rock disintegrated, repairs were made by lining these places with sewer brick. This brickwork was damaged to some extent.—George H. Herrold, St. Paul, Minn.

An Aid to Reservoir-Storage Studies—In studies of natural or artificial reservoirs for storage purposes, it frequently is necessary to determine the rise or fall in the surface level, due to certain rates of outflow and inflow. If the outflow is not constant for the varying levels, the required rise or fall due to a given inflow is ordinarily arrived at by a laborious trial method until a balance is reached between the various factors. For illustration of the method herein described, let a reservoir of 100 sq.mi. be assumed, with a discharge curve

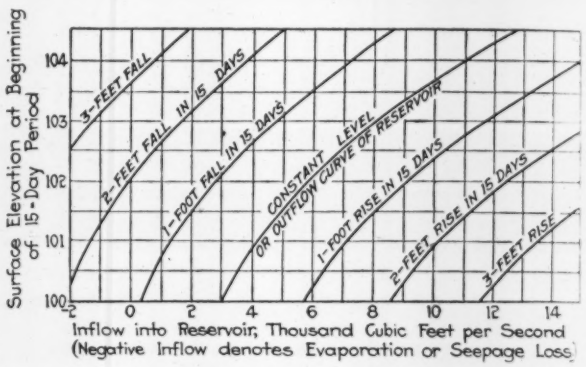


CHART FOR DETERMINING CHANGE IN SURFACE LEVEL OF RESERVOIR

as shown by the heavy line in the figure. The theoretical rate of inflow (including rainfall on, and evaporation and seepage from the reservoir) is equal to the average rate of outflow from the reservoir plus or minus the rate produced by the rise or fall in the surface level over the given period. By assuming several initial levels within the limit of probable requirements, and several rates of rise and fall during a period of 15 days, the corresponding inflow is determined, upon which the remaining curves in the figure are based. In using such a chart the above process is merely reversed. Given any inflow, and a certain reservoir level at the beginning of the period, the rise or fall during the period may be directly taken off. For a level of 102 and an inflow of 10,000 sec-ft., the reservoir will rise 1.25 ft. during the half month. The chart may be constructed for any shape of outflow curve, and for any period of time, and where there are a considerable number of computations to be made it will prove a time-saver.—George M. Shepard, Assistant Engineer with Adolph F. Meyer (Consulting Engineer), Minneapolis, Minn.

Brick Pavements Versus Traction-Engine Parades—We have about 32,000 sq.yd. of brick pavement in Billings, Mont., all laid in 1910. After the brick had been in service about a year, there was a convention of traction-engine manufacturers; and they had a big parade in town, and the citizens of course, were all worked up because the Billings Boosters wanted to keep these people in town. So they decided to have the parade up Montana Ave. and over the bricks, and they came up to the city hall and asked if it would be satisfactory to do this, and the city engineer said it would not. One of the principal Boosters said, "We don't want any grass to grow on our streets; wear out these bricks, and we'll put down some more." As a matter of fact, the traction engines used our bricks pretty severely, and we have had quite a lot of trouble because of this traffic.—John Edy, Highway Engineer, Billings, Mont.

Editorials

Chief of Engineers' Report on Seacoast Defenses of the United States

As a result of the discussion on national preparedness during the past year or more, it has become generally known that the fortifications on which the United States relies for the defense of its principal seaports are very far from constituting the complete protection against attack by a hostile force that the general public has hitherto supposed. Especial interest, therefore, attaches to the remarks on coast defenses in the annual report of Gen. William M. Black, Chief of Engineers, just issued.

Few realize, probably, that the existing coast defenses of the United States were planned by a board that made its report in 1886, *thirty-one years ago.* It is true that twenty years later a second board, of which ex-President William H. Taft, then Secretary of War, was the head, reviewed the coast defenses of the country and recommended various additional works; but the greater part of that board's recommendations had to do with such accessories as fire control, provision of searchlights, power plants, defenses by submarines, mines, etc., rather than with the construction and location of new fortifications.

The fortifications planned by the board of 1886 were adequate for that day, but there have been revolutionary changes in the conduct of warfare in the thirty years since. The European War has made these changes matters of common knowledge at the present day. General Black says in his report:

> When designed and constructed, our seacoast batteries were thoroughly modern; but the work of battery construction has in the past few years been allowed to practically cease and has not kept pace with the recent progress in naval development.
>
> It cannot be too emphatically stated that the art of fortification must continually grow to keep pace with the new discoveries which give it special advantages or to meet and offset progress in the development of naval vessels against which the forts are expected to contend. In locating and designing batteries, the range and power of the naval guns must be given consideration, and unless our fortifications are to become obsolete, changes in any of the elements of naval defense must be met by corresponding changes in seacoast batteries.
>
> These changes must in most cases consist in the construction of absolutely new batteries in new locations. The older batteries were necessarily designed and located so as to obtain the maximum effect with guns of a certain range. If more powerful and longer-range guns were mounted in these older batteries, a large proportion of this increased power and range will in most cases be lost.

In discussing the present condition of our seacoast batteries it must be remembered that the chain of defense which prevents a hostile force from successfully attacking a seaport is no stronger than its weakest link; and the guns and fortifications at the entrances to our seacoast harbors are not the weakest link in this chain of defense. It has long been proverbial in military science that ships cannot successfully attack fortifications. This was proved by experience in the Spanish War and in the Russo-Japanese War, and notably in the present war by the unsuccessful attempt to capture Gallipoli. Although our seacoast batteries fall short of what they should be to cope with the latest type of naval vessels, it is probable that a hostile force would choose other means of reducing them than direct gunfire. Concerning this, General Black says:

> Experience has shown that a direct attack of land fortifications from the sea is so hazardous to the attacking fleet and so rarely successful as not to be undertaken under ordinary circumstances. The attack usually is made from the land by an expeditionary force placed on shore at a point distant from and not covered by harbor-defense guns. Such an attack would be supplemented by attacks from the air.
>
> Adequate preparation for defense against these attacks has not yet been made. Mobile army forces must be available on the exposed frontier in numbers sufficient to provide for patrols along the shores, for outposts to reinforce the patrols and for a reserve close enough to reach the threatened point before any large enemy force can be debarked and can secure its position by intrenching. Field artillery of all classes must be provided; armored trains, with and without heavy ordnance, must be provided for the patrol of exposed coasts bordered by railways; and—equally important—anti-aircraft guns must be provided in numbers for protection of our fixed military utilities against destructive attacks from the air. Comparatively little has as yet been done along these lines.

This statement of the danger which would threaten American seacoast cities in case of attack by a hostile force is of course not new; but to have it thus authoritatively stated by the Chief of Engineers of the Army should end all controversy as to the facts of the case.

Engineers Discuss Americanization

It is significant, surely, of a revolutionary change in social standards and ideals when one of the most famous mansions of New York City, which once represented all that was most exclusive in ultrafashionable society, opens its doors to a great gathering of American engineers, not as a purely social affair but to discuss the methods by which engineers may take a leading part in the task of making foreign immigrants into real American citizens.

Mr. and Mrs. Vincent Astor gave a dinner last Friday evening, at the Astor residence on Fifth Avenue, to 170 prominent members of the American engineering profession, in coöperation with the Committee on Immigration of the National Chamber of Commerce. Last year several luncheons were given by Mr. and Mrs. Astor and other leaders of New York society in connection with the organization of a committee to provide plans for better housing facilities for the poorer classes of industrial workers. This is considered one of the most practical steps in Americanizing the immigrants from foreign lands.

The question may fairly be asked, what are the practical things that the engineer can do to further the work of creating a true American spirit in those who come to this country from foreign shores, and also, as was brought out by one of the after-dinner speakers last Friday night, among the many natives of America who are sadly lacking in any realization of responsibility for their citizenship.

To fully answer this question would require a volume; ut this, at least, can be said, that engineers as a class

are at least as fully alive to their duties as patriotic citizens as are the men of any profession or occupation.

A fine illustration of the patriotic spirit among engineers was the prompt and hearty response of the engineering profession to the appeal for aid made by the Naval Consulting Board last year in preparing the inventory of American manufacturing industries. Another illustration is the widespread interest shown by engineers in the courses of lectures on military training in the practice camps and other movements of the past year aimed to arouse Americans to a better conception of their national duty.

Engineers are well aware that the general treatment of immigrants employed on construction work or in factories has until recently been open to criticism from many points of view. A great change in these conditions has already been brought about, partly through the initiative of some of the large employers of labor, partly through the admirable work done by the international Young Men's Christian Association in developing courses of instruction in "human engineering" in the leading engineering schools, and partly as the result of conditions in the labor market.

It is unfortunately true, however, that on many classes of work for which the engineer bears responsibility, those who hold the purse strings have placed so much emphasis on efficiency and economy that there has been no time or money left to devote to the work of bettering the condition of the human beings who are employed. Where conditions are such that the engineer can do something practical for the men under his direction, he will generally be found ready to take the lead in this most important work.

Inadequate Railway Terminals and the High Cost of Living

A joint report has recently been made on food supplies and prices for New York City, by three committees—one appointed by Governor Whitman of New York, another by the New York Legislature, the third by Mayor Mitchel of New York City. In a chapter of this report dealing with the relation of the means for transportation to high prices for food the committee says:

> It has been estimated that it costs very much more to transport a pound of food from the point where it lands on reaching New York to the home of the consumer than it does to bring it by rail all the way from Buffalo to New York. The present inadequate track, yard and terminal facilities of the New York Central R.R. are serious handicaps to the producer in the marketing of food products. A thousand or more cars at a time are often held up north of Spuyten Duyvil. The yards at 130th St., 60th St. and 30th St. are so inadequate as often to cause 150 to 200 cars of produce at a time to be held on back tracks awaiting placement on team tracks. Cars loaded with produce are sometimes detained in these yards on an average of five days beyond the free time of two days. The consequence is a large additional expense, a shortage of produce cars and the issuing of embargoes, with such demoralization that farmers often hesitate to ship to New York City and endeavor to seek markets outside the state. Similar conditions exist with practically all the transportation companies.

There is no question as to the facts that the committee recites, but the question how to solve the difficulty is one not easy to answer. The New York Central has made plans for expending some $50,000,000 to provide better means for bringing its freight and passenger traffic into New York City on its west-side lines. Some experts who have studied this problem, however, believe that when the interest, taxes and sinking-fund charges on this huge investment are included, the cost of handling cars on the New York Central's new west-side lines will hardly be less than at present.

The delays due to congestion may indeed be remedied for a while; but it will be no very long time, presumably, before the capacity of these terminals also will be reached and exceeded. Probably there is no really cheap way of handling freight cars on Manhattan Island.

It is difficult to propose anything better for the traffic from the north over the New York Central lines, admittedly. To the westward, however, in New Jersey, there is still plenty of room for adequate railway terminals, which would be much nearer to the congested regions of New York that must be supplied with food than are the uptown yards of the New York Central. Such a solution is dependent, manifestly, on more adequate means of crossing the North River; and the problem of bridges or additional tunnels there is one that is receiving increased attention.

Automobile-Engineering Development

The American Society of Automobile Engineers held its annual meeting on Jan. 11 in the auditorium of the Engineering Societies Building. This society, which was not dreamed of when that building was constructed a dozen years ago, has now a membership of over 2000; and it filled the auditorium with such a large audience as has seldom been assembled there at any technical meeting, even of the great national engineering societies. The papers presented at the meeting were as scientific in their character and as well entitled to rank as engineering literature as are the papers read before any of the older national societies.

In the early days of the automobile it used to be predicted that its coming was a passing fad and that it would disappear as quickly when the fashion changed as did its predecessor, the bicycle. Few would be found today to take this superficial view. The engineers of the automobile industry who are applying mechanical power to road locomotion are dealing with as great a problem and are devoting vastly more scientific methods to its solution than did the engineers of eighty years ago who applied mechanical power to railway transportation.

The motor vehicle is already producing social and economic changes quite comparable with those wrought by the locomotive. The rapid growth of the industry is the most amazing illustration the world has ever seen of the possibilities in the large-scale manufacture of machinery.

In the commercial-vehicle field the displacement of the horse has been slower; but the last two years have seen a great advance in the use of the motor truck and delivery car. The high price of feed and of horses since the war began has stimulated the demand for motor vehicles. The business is also rapidly developing of transforming second-hand pleasure cars into commercial vehicles. The farm tractor is being rapidly developed and improved to a point where it will become a much stronger competitor of the horse.

A question that has been seriously raised many times during the past two years is whether a limit to the development of the motor vehicle will not be set by the lack of fuel to supply the enormous and rapidly increasing demand. That higher prices for motor gasoline are inevitable is generally agreed by those qualified to judge.

Present prices of crude petroleum in Eastern fields are higher than have ever before been recorded. A large proportion of the newer oil fields produce heavy asphaltum oils, from which only a small percentage of gasoline can be extracted.

The first solution of the problem of fuel supply will doubtless be through the use of heavier oils. With the motor boat and the farm tractor, the use of kerosene is already practicable. On many commercial automobiles no very great changes in construction will be required to make possible the mixture of a large percentage of kerosene with the gasoline.

The operation of the motor vehicle is, moreover, not wholly dependent on gasoline. Even at present prices of motor fuel the storage-battery vehicle is an important competitor of the gasoline motor truck and pleasure car.

Another possible competitor for the gasoline vehicle is the steam car. At the recent New York Automobile Show the exhibit that attracted the greatest amount of attention was the new steam automobile which has been developed by Abner Doble, of California, an engineer who has been a prominent figure in water-development.

Among the novel features of the Doble steam car are a sectional water-tube boiler, with autogenous-welded joints, which is claimed to be so rugged and to have so small a water volume that steam pressure can be raised in one minute after lighting the fire. Kerosene serves for fuel, ignited by a spark; and a slow-speed uni-flow engine is used, connected to the rear axle so that a large part of the mechanism of the gasoline automobile—clutch, transmission gear, etc.—is eliminated. Fuel economy practically equal to that of a gasoline car is claimed.

It will be obvious that the steam motor vehicle has much greater possibilities in the application of low-grade fuels than the car driven by a gasoline engine. The advance in the price of gasoline will therefore give a stimulus to the development of the rival system. It may fairly be concluded that the application of mechanical power to road transportation will not come to a halt because of lack of fuel.

Salaries of Government Engineers

Interesting sidelights on the compensation of engineers in the Federal Government service are contained in the 1916 annual report of the Superintendent of the United States Coast and Geodetic Survey. He prefaces his plea for increases in salaries for the survey's hydrographic and geodetic engineers by the following:

> **The old theory about the civilian appointments in the Government was that any man was fortunate who retained his job for more than four years, however insignificant the position and however small the pay. This was in the days before it was found necessary to enact civil-service laws and put them into effect. Now the Government considers itself very fortunate if it can retain experts in its service for more than four years at salaries much smaller than those ruling in similar work in private life.**
>
> **The Government is the largest single employer of skilled labor (for the sake of argument, calling all who work for salaries or wages laborers) in the country. It is also the most inefficient employer. It sees 15 or a larger per cent. of its skilled employees leave each year. These are, as a general rule, the most able and most efficient ones. The least able ones remain, and on account of long and faithful, but many times not notably efficient, service they reach the highest salaries.**

The report then outlines the difficulty in keeping Survey officers: In the six years since 1909, out of a total of 99 field officers 66 have resigned their positions. This does not include any vacancies on account of death. Nearly all resigned to take up work paying higher salaries or with prospects of an increased income, or because of the hardships incident to the life of a field officer in the Survey.

The report contains the accompanying table of comparative average salaries. The conclusion stated is that the Coast and Geodetic Survey officers are the poorest paid of any of the Government engineers and that Government employees as a whole are poorly paid.

COMPARATIVE SALARIES OF ENGINEERS

Service	Average Pay	Reference
American Society of Civil Engineers*	$4,141	Report of committee of society, January, 1917
41 civil engineers, United States Navy	3,429	1916 Estimates, p. 1078
226 engineers, United States Army	3,008	1916 Estimates, p. 292
Geologists, Geological Survey (73 annual employees)	2,130	1916 Estimates, pp. 791-798
Topographers, Geological Survey (57 annual employees)	2,164	1916 Estimates, p. 792
Bureau of Mines (34 annual employees)	2,662	1916 Estimates, p. 806
Patent Office (396 annual employees)	2,019	1916 Estimates, p. 95
Hydrographic and geodetic engineers, Coast and Geodetic Survey (104 annual employees)	1,720	1917 Sundry Civil Act
Hydrographic and geodetic engineers, if granted increase requested (152 annual employees)	1,900	1918 Estimates

*The Survey report gives the average of the 1915 report of the Am. Soc. C.E.

In interpreting these figures, however, there are several points not mentioned in the Coast Survey report which it is necessary to know to make a fair comparison. First, the Government salaries include everyone and are real averages, while the American Society average undoubtedly includes a larger proportion of the higher-salaried men than of the lower-salaried ones. One-third of the members made no returns, and if this third were the low-salaried third, as it is permissible to asume, the general average would be much reduced, if this average were made comparable with the Government figures.

Again, many Government engineers are allowed regular sums for subsistence when away from headquarters. Coast Survey officers, for instance, are allowed $2.50 per day when acting as chiefs of parties and in the Philippines. All other officers are allowed $2, except aboard ships on our own coasts, where the allowance is $1 per day. These sums are paid outright, and they are not necessarily actual living expenses. An officer who spends nine months a year in the field as chief of a geodetic or a hydrographic party may thus have a salary of $1800 per annum and a commuted subsistence allowance of 270 × $2.50 = $675, or a total income of $2475. In reporting his professional income to the American Society he could properly give $2500, while the remuneration of the same individual appears in the Government table as $1800.

If the Coast Survey finds it hard to fill up its roster of officers, these facts should be just as widely published as the others. Moreover, it is certainly unjust to the many able and efficient officers now in the service to state that "the least able employees remain." Many a young fellow goes into the Coast Survey for the specific purpose of getting a year or two of its training and then quitting.

Like every other organization, the real working personnel of the Survey represents the survival of the fittest—those who love the work for the work's sake; these are the real workers in all professions. That their salaries are low and should be increased to meet modern living conditions is only too true, but the same holds true of a large proportion of the salaried men in many callings, especially those in scientific pursuits.

Letters to the Editor

The Ohio Conservancy Act

Sir—In "Engineering News," Dec. 21, 1916, p. 1190, Clemens Herschel criticizes the Ohio Conservancy Act. He begins:

Let us briefly review the act. It provides for the appointment in any county of commissioners. Note that two mistakes have already been made, for (1) County lines are no proper boundary of jurisdiction in matters of engineering construction, especially not for flood protection; (2) nor is an emergency commission of laymen a proper body to oversee to the best advantage the design, construction, operation and maintenance of such works.

Unfortunately neither of these two statements is true. The law provides for the organization of conservancy districts entirely regardless of county lines. The fact that the Upper Scioto Conservancy District, with which Mr. Herschel had a brief acquaintance, accidentally lies in a single county may have led him to reach his conclusion without having read the act itself.

Under the act a conservancy district becomes a corporate body governed by a board of directors much as a railroad company is governed. To call a body of directors laymen because they are not engineers is to assume that such a district has no functions except those of an engineering nature, just as in a similar case we might assume that all the functions of a railroad are engineering functions and that therefore a board of directors not consisting of engineers would be a board of laymen.

Mr. Herschel also states that the law should "operate on drainage areas and not counties or parts of counties or on parts of drainage areas." This is an academic statement which falls completely when examined in detail. Is a drainage area the Ohio River with its branches, or the Miami River and its branches, or one of the branches of the Miami River? Must we assume that until an entire drainage area on a river is ready for improvement no part of this area can be improved? Can no marsh be drained, can no city be protected, except through an organization comprising the entire drainage area? Theoretically this is a fine ideal, but those who have watched the actual development of our Western States know that it is impossible—and the engineering profession gains in prestige and influence in proportion as it realizes what methods are effective and possible in public improvement and keeps away from schemes which are entirely impracticable. To confine any large drainage area in Ohio to a single organization requiring the action of the entire organization to bring about any improvement, whether that improvement be a village ditch or a great flood-prevention works, would result in preventing entirely the effective operation of a water-control code. The Ohio Conservancy Act very wisely provides that the determination as to whether an entire drainage area, or only a part of it, should be included in a conservancy district should be made upon the facts presented in each particular case and not upon any theoretical assumption made in the statute itself.

The writer thoroughly agrees with Mr. Herschel that:

We are approaching the day, if it is not already here, when permanent organizations for the construction and care of all public works will have to be provided for.

Whether it is time for such an organization in any state can only be determined by a knowledge of conditions in that state. In general it is true that unless a need for such an organization is felt before such an organization is created, its creation is apt to be a matter of politics. In one state where such an organization has been created a country newspaper editor has been placed in charge of the bureau and is acting as consulting engineer on the reclamation projects of the state. Any engineer who does not become a part of his political organization is not looked upon with favor. In another case a state officer who is not an engineer and has no training or experience in engineering is given charge of the water-control functions within the state, and has it specifically in his power to pass upon the qualifications of every engineer employed on such work within the state. It has been said that he is using this power for definite political ends. These are simply illustrations to indicate that whether or not the time has arrived for the creation of a state bureau depends upon local conditions, a knowledge of which is required before an accurate judgment can be expressed.

In his statement of engineering facts, Mr. Herschel is also in error. Speaking of the plans of the officials of the Upper Scioto Conservancy District, Mr. Herschel states that it was "no concern of theirs that this would spoil the plans of the Franklin County Conservancy District, for they are looking out only for their immediate clients or petitioners." The fact of the matter is that the plans of the two districts were considered as to the effect of the upper upon the lower, and it was found that the work of the upper district, which controlled less than 10% of the entire drainage area, would have very slight effect upon the works below. The plans of the two districts were worked out in harmony.

Dayton, Ohio, Dec. 30, 1916. ARTHUR E. MORGAN.

Good Roads Not an Invidious Benefit to Motor Truck Owners

Sir—I have read with a good deal of interest Prof. C. C. Williams' letter to you relative to duplication of transportation facilities, in your issue of Jan. 11, 1917, p. 80.

As I understand it, Professor Williams takes the attitude that it is unwise to build trunk-line highways between cities, but that it would be wiser to devote state moneys to the building of better highways locally.

The writer is compelled to disagree with Professor Williams' conclusions as stated above for the following reasons:

There has been an enormous growth in the use of commercial vehicles by the farmers to bring their material to the local freight stations, and the advantages in many instances which accrued in this way encouraged the farmer to bring his material direct to the city markets. The writer has noticed an exceedingly large number of motor vehicles employed in the States of New York and New Jersey by farmers, bringing in garden produce to city markets from distances up to 50 mi. It would not pay the farmer of course to bring grain, oats and other commodities which are staples any such distance with motor trucks, if convenient railroad facilities were available, but the railroad rates on perishable freight are so high, together with the fact that the farmer is enabled by the use of motor trucks to deliver his garden produce so much quicker, with so many less handlings to the city market, that the products arrive in much better condition, thus being worth much more money. Further this enables the farmers to sell direct to the retailers, rather than through jobbers and other middlemen.

The summation of these reasons makes it very advantageous to the farmer to utilize motor trucks instead of railroads for garden produce, and correspondingly enables the city dweller to purchase the goods in better condition for less money.

The writer wishes to call attention to the fact that in many instances railroads were projected through territory where population and freight were very scarce, but where future possibilities of development justified the building of the railroad. The same condition applies to the building of good roads of such a character that they can be utilized for commercial traffic, not only in regions which are parallel with railroads, but also regions where railroads are more or less remote, for some of the railroads have reached the mental state where they are encouraging commercial motor transportation as feeders to their system.

While this last statement would seem somewhat contradictory, upon analysis the real underlying meaning will appear.

The writer wishes to call attention to the fact that in most states state funds are not contributed in any degree to the initial building of new roads or the maintenance of old roads, within municipalities.

In most instances railroads have been projected through regions which showed possibilities of traffic developing. State roads built through these regions naturally would be of service to more people than roads built through sparsely populated regions, except in the case where regions are sparsely populated owing to the fact that they are inaccessible, rather than on account of their lack of fertility.

There are many fallacies and misconceptions regarding the usage of commercial motor vehicles, and one of them is that the apparent attitude many people take that operators of

motor vehicles are specially favored when good roads are placed at their disposal.

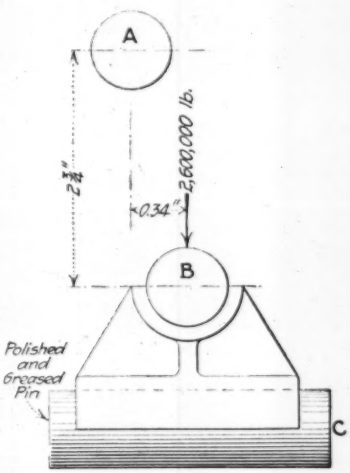
It should be distinctly understood that nobody operates a commercial vehicle except for utilitarian purposes and that the benefit which accrues from such usage, in some way or other is beneficial to the people as a whole and not alone to the person or concern which operates these trucks, for the same principal that underlies all business, and that is, that any service rendered must be of more value to the purchaser than what he pays for it. GEORGE H. PRIDE.

1328 Broadway, New York City, Jan. 20, 1917.

Support of Quebec Suspended Span

Sir—I should like to submit as a comment on R. S. Foulds' letter in your issue of Dec. 21, 1916, the accompanying sketch, with the query, How did pin C freeze in the horizontal position? This query will be understood by anyone who has followed the matter of the alleged stability, not strength, of the Quebec Bridge lifting scheme, but a little explanation may serve to make it clearer to those who have not followed current comments on this disaster.

A represents the lowest pin in the suspending chain of bars about which the girder supporting the truss shoe could rock; B is the pin carrying the end post of the truss, and C is the longitudinal pin. The idea meant to be conveyed by the sketch is the absurdity of the pin C remaining horizontal when the girder supporting it was lifted, as Mr. Foulds' letter indicated it would, because the friction on the pin A was too great for it to rotate in spite of the tremendous load and the lever arm of 0.34 in. and the jarring due to lifting. These pins were well polished and well greased. In my judgment, as the girder was lifted and jarred, the pin B would rapidly find its place vertically below A; and even if the offset were only a trifle over ⅛ in., as suggested in Mr. Foulds' first letter, the slope would be sufficient to be the sole cause of the wreck of this bridge.



SKETCH OF PINS AT END SUPPORT, QUEBEC BRIDGE, SUSPENDED SPAN

EDWARD GODFREY.

Monongahela Bank Building, Pittsburgh, Penn., Dec. 26, 1916.

Decimal Angular Measurements and Centesimal Division of Quadrant

Sir—Referring to a letter entitled "Field-Artillery Service for Civilian Engineers," in "Engineering News" of Sept. 21, 1916, p. 564, the editorial tail note of that letter states: "The incipient surveyor-inventor looking for opportunities to introduce new methods may possibly see the germ of a valuable improvement in the decimal system above described."

One of the things quite apparent in the discussion of the method of an artilleryman's measurement of angles is that a decimal measurement of angles is the only one that can be performed with speed. Further, the time that might be saved by all who measure angles and compute trigonometrical functions in all lines of work by the use of a decimal division of the circle would be great. It seems that is beyond dispute.

However, no engineer could be induced to order instruments graduated to read decimal parts of the circle or quadrant, unless he had at hand tables of functions for such division, and tables to convert the present system into the decimal system and vice versa.

In the 1873 "Proceedings" of the British Association for the Advancement of Science may be found a complete catalog of all the mathematical tables published up to that time. Two books listed have tables for the centesimal division of the quadrant. They are: (1) "Log Functions," by Charles Borda—that is, Charles de Jean; (2) Hobert and Ideler's seven-place tables (published in 1799). Concerning Hobert and Ideler's tables the following is said:

(T. 1.) Natural and logarithmic sines, cosines, tangents and cotangents for the quadrant, divided centesimally; functions given for arguments from 0.00001 to 0.03000 of a right angle at intervals of 0.00001 of a right angle, and from 0.03000 to 0.50000 at intervals of 0.00010 to seven places, with differences.

Expressed in grades (centesimal degrees), etc., the arguments proceed to 3^g at intervals of 10", and thence to 50^g at intervals of 1'.

The manner of calculation of the table is fully explained in the introduction, and this adds much to the value of the work. Several of the fundamenta were calculated to a great many places. Two or three constants are given on page 310.

B. Table of natural sines and tangents for the first 100 ten-thousandths (namely, for 0.0001, 0.0002, etc.) of a right angle, to ten places.

C. Four tables, expressing (1) 1°, 2°, 3°, ...89°; (2) 1', 2', 3',....59'; (3) 1", 2", 3", ...59"; (4) 1"', 2"', 3"', ...59"'; all as decimals of 90°, to 14 places.

D. Three tables to express (1) hundredths, (2) thousandths, (3) ten-thousandths of 90°, in degrees, minutes and seconds (sexagesimal).

E. Four tables to express (1) hours, (2) minutes, (3) seconds, (4) thirds, as decimals of a day.

F. Small table to express decimals of a day in hours, minutes and seconds.

Unfortunately, Hobert and Ideler's tables do not include under Table 1 external secants and versines, with differences. If they did, they would be complete enough and close enough (with seven places) for ordinary engineering work, including ordinary triangulation. One virtue they possess is the differences columns. This is very essential for speed in interpolation. The arrangement of tables, also, so that functions that may be needed most often consecutively be listed together, is another important matter. The arrangement of James Pryde's "Mathematical Tables" is good.

I am unable to secure a copy of Hobert and Ideler's tables even for inspection. Possibly some of your readers might be able to suggest other authors of similar centesimal tables or canons who published their works subsequently to 1873. I should like to know whether the work of Hobert and Ideler may be found in the engineering libraries in New York. Apparently no copy can be found in Washington, D. C.

It seems unfortunate that the centesimal division of the quadrant was superseded by the sexagesimal.

VIRGIL A. EBERLY.

Washington, D. C., Jan. 4, 1917.

NOTES AND QUERIES

Pumping Concrete—An engineer having a railway tunnel to line with concrete has inquired as to the possibility of pumping the concrete from a mixer plant at the portal through a delivery pipe leading to the forms. It is desired to compare this with the method of mixing and delivering concrete by compressed air, which system has been used in a number of tunnels.

A Bridge Draftsman Arrested—A draftsman going under the name of Robert J. MacNoll, who was advertised for in "Engineering News" of Jan. 4, was arrested in St. Louis on Jan. 11 on charges of forgery and grand larceny. His arrest was the result of publicity given to his operations at a meeting of the Engineers' Club of St. Louis on Jan. 10. From such information as has been obtained, he has defrauded engineers in Pittsburgh, Chicago and various Western cities, and will now probably receive a penitentiary sentence.

An Attachment for Wire on Concrete Fence Posts has been devised by W. E. Mielly, Engineer of the Contracting and Material Co., Chicago, and he is anxious to know both if the method is practical or if it has been used before. The scheme is to embed a double cone-headed nail in the post about as shown in the sketch, leaving one head and a small part of the shank exposed. After the post is erected and the wire stretched, the double strands of the wire would be forced apart and over the head of the nail. Mr. Mielly says: "It would have to be made of rustless iron or have a thick coating of zinc applied, to make it last as long as the post. I think the cost would not be greater than the ordinary staple. The opinion of those who have had experience along the above lines would be appreciated."

Gypsum-Composition Roof Slabs To Be Used by Navy Department

The Bureau of Yards and Docks, United States Navy, has just awarded a contract for the roof of the new structural shop at the navy yard at Norfolk, Va., for a roof slab to be constructed of gypsum composition, because, according to the official statement, of the saving in weight of structural steel resulting from using a roof slab so much lighter than reinforced concrete and also because of the anticipated saving from the reduction of heat losses through the relative nonconductivity of gypsum as against concrete. This contract was let so that the unit cost of the gypsum slab complete will be about 22.2c. per sq.ft.

In Bulletin No. 25 of the Public Works of the Navy, issued by the bureau, there is considerable space devoted to the subject of gypsum-composition slab construction, mainly a report of investigations made by the bureau before deciding on the use of the material for the building. These investigations consist in inspections of installations of gypsum-composition slab construction and a loading test of a typical floor slab made by the United States Bureau of Standards. Extracts are given below from the reports of the various installations examined.

Civil Engineer George A. McKay, U.S.N., inspected different slab constructions of the Midvale Steel Co., the Baldwin Locomotive Works (Eddystone), Remington Arms (Eddystone), Pennsylvania Shipbuilding Plant (Gloucester) and other installations. He reports partly as follows:

The largest installation seen was at Eddystone, where there are built about 22 acres of roof covered with gypsum-composition slabs. Certain of these slabs have been in use for as long as six years. All slabs inspected were installed in accordance with the table of spans, slab depths and cable spacing and represented standard construction of the Keystone Fireproofing Co. The superintendents of construction or their assistants at the different plants were interviewed, and all information gathered either by inspection or by interview was favorable.

Particular attention was given to the work being installed on Ordnance Machine Shop No. 7, Midvale Steel Co. The roof slabs were 3 in. thick, spans 6 ft. 3 in., reinforcement consisting of two No. 11 wires 3 in. on centers, wires being held down in the center of the span by one ⅝-in. round bar. This slab is designed for 30 lb. live-load. Beam lengths were 17 ft. 6 in.; the end panels were stiffened with three 1½-in. pipe struts, and the center panels were stiffened with one 1½-in. pipe strut. In the end two panels there was a 6x6-in. gypsum beam, 6 ft. 3 in. long, installed for further stiffening of the end slabs. The gypsum composition used contained 15% by weight of wood chips and heavy broken shavings. The bulk of this wood filler, however, was considerable, so that in appearance there was apparently much more wood filler than gypsum.

The gypsum and wood chips were first mixed dry by hand turning, similar to hand concrete mixing, on the ground; were then loaded into sacks, raised to roof by elevator and transported to the site of the work, where the mixture of gypsum and wood chips was again mixed in a box, water being added at the same time. The mixture was then immediately shoveled on the forms and screeded to proper elevation.

The company's force consisted of a total of 75 men, which force laid 7500 sq.ft. per day. There were about 12 men dry mixing, 2 men on hoist and 8 men for wet mixing and screeding. The remaining men were employed placing reinforcement and forms, stripping forms and on miscellaneous work. Within 15 min. after a slab was poured it was possible to step upon it without leaving a footprint. A slab that had been poured at 9 o'clock had the form stripped at 11 o'clock. Seventeen men were then put on this slab in a space about 8x6¼ ft., which represented a live-load about double that for which the slab had been calculated. The slab adjacent to the one loaded was without load. No deflection was noticeable to the eye, and there was no apparent injury to the construction. At the time this first load was applied, the gypsum slab was so soft that it could be slightly compressed under the pressure of the thumb. The gypsum slab construction is quite elastic, and when compared to concrete is comparatively soft under foot, particularly so until it has thoroughly dried out, which takes about three weeks' time.

Civil Engineer L. M. Cox, U.S.N., reported on certain installations around New York City, with the following general abstracts:

The advantages of gypsum slab construction are:

A. The light weight of slab, thereby reducing dead-loads and decreasing cost of steel, foundations and piles.

B. Quick construction, as forms can be removed in less than 24 hr. and roof covering can be placed in advance of the time required on concrete slabs.

C. The material, being a nonconductor, decreases heat losses through roof, reduces coal consumption required for heating and is free from condensation on the under side of the slab.

D. The material has successfully passed several fire tests conducted by the Bureau of Buildings, New York City, and at the Columbia University fire-testing station at Brooklyn.

E. There was a noticeable absence of cracks on all installations inspected, which is undoubtedly due to the elasticity of the material.

F. The cost of maintenance and repair is low. The slabs are easily cut out where changes and construction are necessary; nails can be driven in the slab at any time.

This construction has the disadvantage that it is impracticable for the contractors to obtain wood chips which are free from oak and chestnut; and where these occur in the wood filler, brown stains are developed on the under side of the slab. Asbestos filler has been used in an effort to avoid this stain, but asbestos has been found unfit because of a chemical action which takes place which results in a white salt developing on the under side of the slab, which is more objectionable than the stain for the average installation. The slab is very porous, absorbs moisture freely, and when used for roofs must be waterproofed. The compressive strength of gypsum is diminished by being wet, but it regains its strength in large part when redried. It is not considered that the decrease in strength of the slab when wet is sufficient to materially affect the strength of the structure when used for light loads and short spans.

The bulletin further states that letters requesting information concerning different slab installations were sent to a number of important companies and of the seven replies received all were favorable. Information was particularly requested as to the length of time the system had been used, whether any trouble had been experienced with cracks due to irregular loading of vibration, as to any deterioration in the slab where it had been exposed to moisture or rain, as to the effectiveness of the slab in decreasing heat losses and in preventing condensation, and as to whether the installation had been entirely satisfactory.

A well known system of gypsum slab construction consists of steel cables placed in tension in the form of suspension members over I-beam supports, the whole embedded in a slab of mixed gypsum and wood chips. A slab of this type, known as the Metropolitan System, was tested by the bureau. The bulletin states that the method used by one of the companies manufacturing such a system in figuring the strength of the slab is not approved, although it appears to be safe for ordinary installations. It is believed that a method of analysis similar to that used for reinforced-concrete construction would give results that would conform more nearly to those which actually occur in the installation. Calculation on the latter basis for a roof of spans and loading as specified for the structural shop showed that the slab should be 4 in. thick instead of 3½ in. thick, as recommended by the manufacturer.

It is also believed that a change in the system of tying down reinforcing cables would result in a material improvement in the construction.

Final conclusions in the bulletin are as follows: Gypsum-composition slabs are recommended for roof construction such as will be needed for the structural shop at Norfolk and also for light floor construction where no concentrated loads occur. Gypsum slabs are not recommended for floors having heavy concentrated loads or for large spans—that is, 8 ft. or over in width—nor for office floors or roofs where stains on the under side would form a serious objection.

The loading test made by the United States Bureau of Standards is given in complete detail in the bulletin, but is too lengthy to abstract here.

Discussion of the American Society's Road Committee Report

The annual discussion on road materials and construction, under the auspices of a special committee (now of seven years' standing) of the American Society of Civil Engineers, was held in New York City, Jan. 19. This seems to have become the occasion of a kind of "indoor sport," which consists of shooting holes in each successive report of the committee.

The task the committee has undertaken is admittedly no sinecure. It has expanded from that set before the special committee in 1909 of reporting on "bituminous materials for road construction and on standards for their test and use" to one which evidently includes a definition of principles (and in some instances specifications) governing all road and pavement construction. The committee's excuse for going into the "general principles concerning materials and their use" is that "a neglect of their proper consideration is often to be found" and the committee "recommends that the neglect of these considerations be not allowed by any one to occur in any case"—whatever that may mean.

The report undertakes to fix maximum grades for various kinds of paving. The criticism of these was that 12% was too high for gravel and broken stone, due to damage from wash, that 6% was too low for bituminous surfaces, 5% too low for sheet asphalt, 8% too low for concrete, 6% too low for brick with grout filler, and 4% too high for wood block. A large part of the criticism of course came from those who were interested in promoting some one of these varieties of pavement. The table of thicknesses of pavement and foundation was criticized as giving figures 30% less than corresponding European practice.

In the section on bituminous pavements, the statement of the committee that "whenever comprehensive specifications are to be prepared, so as to permit a variety of types of bituminous materials, separate specifications, as may be necessary, should be prepared for each case," was on the whole commended as entirely justifiable with our present knowledge of bitumens. The option of using a certain brand of material under this specification, however, should be with the contractor and not with the party awarding the contract, which avoids the abuse which has been made of so-called alternate specifications.

As was to be expected, there was a large amount of difference in the opinions expressed in regard to bituminous macadam and bituminous concrete pavements. One gallon of bituminous material per sq.yd. per inch in thickness of top course in penetration work was held by many to be an excessive amount. The statement was made by several speakers that pavements were more often spoiled by use of too much bitumen than by too little. The necessity of using stone larger than ¾ in. (as recommended in the report) for the covering material was emphasized where it was necessary to use the softer varieties of rock.

The discussion of sheet-asphalt pavement was chiefly in regard to the necessity of a binder course. It was developed that in Omaha, Neb., and Wilmington, Del., asphalt pavements have been laid without binder courses, using a 50 to 55 penetration asphalt. In Omaha there has been some creeping of the wearing surface of these pavements under heavy traffic, but the Wilmington experience was said to be without detrimental results. The committee's recommendation that "in cases where sheet asphalt is constructed next to the curb, it is advisable to coat the surface for a space of 12 in. next the curb with hot asphaltic cement" was said by Clifford Richardson to be an obsolete practice.

Concrete pavements were somewhat scantily treated in the report and the general sentiment seemed to be expressed by Samuel Whinery when he said that "every one would be disappointed in the amount of information it contained, that nothing was said about one- or two-course pavements or about the application of bituminous surfacing." Various individual items were criticized by A. N. Johnson, of the Portland Cement Association, who said that the report did not bring out the proper methods of finishing. He said that some method of compressing the wet concrete in place, and removing the excess water, as by use of heavy plank floats at Sioux City, Iowa (see *Engineering News*, July 29, 1916) and by use of wood rollers at Macon, Ga. (and Charlotte, N. C., as described in *Engineering News*, Oct. 26, 1916), was necessary to obtain the best results.

The question of sand-cushion or monolithic type of construction for brick pavements was again discussed, and the report's contention that a desirable cushioning effect was secured by a bedding of 1 in. of sand was upheld by Prevost Hubbard, of the United States Office of Public Roads and Rural Engineering, who said that tests made in the laboratory at Washington showed that the sand gave a decided cushioning effect under impact, and that a brick and 5-in. monolithic foundation broke under exactly the same impact as a brick with a 1-in. cushion between it and the 5-in. foundation, which apparently disproved the theory that thinner foundations with the monolithic type of construction are justified.

The part of the report on wood-block pavement was criticized chiefly as being too specific. This part is made up of the specifications drawn by a joint committee of the various engineering societies which met in Brooklyn, N. Y., last fall, and differs from the greater part of the American Society of Civil Engineers' committee report in being specific in details. Since every other engineering society either has or will soon adopt these wood-block specifications, it was evidently considered safe to include them in the progress report.

Since the joint committee adopted these specifications it has been discovered that the recommended, or rather suggested, steam treatment before the final or supplemental vacuum, is a patented process. It was stated, however, that the patent could be side-stepped by doing the steaming after the final vacuum instead of before.

News of the Engineering World

Proposed New Jersey Highway Reform

At the recent close of his term of office, Governor Fielder of New Jersey, transmitted to the legislature the report of the commission appointed to investigate the matter of improved highways and to formulate a road policy for the state (see *Engineering News*, July 27, 1916). The same legislature provided a bond issue of $7,000,000, which was approved by popular vote in the November election, but has since been held to be illegal by the state attorney general.

The special commission recommends a highway commission of three members, appointed by the governor with the consent of the state senate. The commissioners would receive $25 for each meeting attended, not to exceed $1000 per year, their terms to be for six years, with the power of removal by the governor. Full responsibility and authority for the selection of routes for the state highway system would be vested in this board.

It is recommended that there be a state highway department composed of the state highway commission, the county boards of freeholders and the governing bodies of incorporated municipalities of over 2500 population. This department would be subdivided into a state branch, county branches and municipal branches, each branch having its own engineering bureau.

The chief officers of the state highway department would be a state highway engineer (salary not to exceed $10,000), a secretary of the commission (salary not to exceed $5000), and such assistant state highway engineers (at $5000 or less) as might be necessary. The present county engineers would be continued in direct charge of the engineering bureaus of the county branches and eventually be placed under civil service. The municipal branches would be under the city engineers. This plan would make county and city engineers state officers, so far as their road work is concerned. They would be under the general supervision of the state highway engineer; as to street pavements, this supervision would be limited to such of these highways as form connections with the general system and would not involve the state's assuming complete control. The purpose is to assure such connections through densely populated districts as are required for through traffic, by means of help extended to the governing bodies in charge and by supervision of the work on such connecting streets. The report recommends that the proposed state highway commission be empowered to fix certain minimum requirements, such as width of roadway, width of pavement, thickness of foundation and pavement, type of surfacing, etc.

The special commission adopted 1250 mi. of highway for a principal or state system, 1250 mi. for "feeder" highways, and 1250 mi. of branch highways, as a basis of the system to be improved. It is proposed to construct the 1250 mi. of main or trunk lines in the five years 1917-1922. The estimated cost is $25,000,000, of which $888,000 would come from the Federal Government, $3,500,000 from general state appropriations, and $9,660,000 from motor vehicle fees, making a total of $14,048,000. The balance would be raised by a state tax of $1 per $1000 per year for five years, which it is estimated would yield $14,000,000, making a grand total of $28,000,000. Of this the extra $3,000,000 would be used for maintenance and upkeep.

Indiana Engineers Reminisce

Historic and romantic aspects of the engineering profession were brought out at the 37th annual meeting of the Indiana Engineering Society, which was held Jan. 18-20 at Purdue University, Lafayette, Ind.

The important relation of the work of the old-time pioneer surveyor to the development of the country is not often realized, but was set forth in a convincing and interesting manner in a paper by George R. Wilson on "The Vincennes Tract and the Freeman Survey." The Vincennes tract was an area (in what is now southern Indiana) granted by the Indians to the French some 200 years ago; this was taken from the French by the British, and eventually taken from the latter by the Americans under General Harrison. It was inaccessible to the "white man" except by crossing Indian lands, but General Harrison secured a further grant extending to the Ohio River, then one of the great routes of the settlers and pioneers.

Mr. Freeman was the surveyor employed by the United States Government to run the boundaries of this tract of land, about 1790. The lines are still known as "the Freeman survey." This, of course, was long before the State of Indiana was established. These lines have been retraced in recent years, and found to be very accurate, and there is a movement to perpetuate the monuments in order to mark an historical development of the country.

Following this paper a talk on "Reminiscences of an Indianian" was given by Gen. Anson Mills, U. S. A., who graduated from West Point in 1857. He was a surveyor and engineer in early days in Indiana and Texas, and more recently a member of the Mexican Boundary Survey Commission. He gave many examples of the work, the difficulties and the enterprise of the pioneers of his own youthful days. In concluding his address he pointed out the resourcefulness and self-help of these men (and women too) under the spur of necessity, and he urged a return to such conditions under modern aspects. His idea is to establish a county community having water-supply, sewerage, electric light and power, and modern conveniences, where farm work and manufacture can go hand in hand. He asked the assistance of the Indiana Engineering Society in this work, and offered $5000 to the first county which will raise $45,000 in addition for establishing and equipping such a community. It is of interest to note here that a few years ago General Mills gave to his home town a memorial to his mother and father in the shape of a water-works system, a gift of more practical and permanent value than a marble monument.

In a paper on "Human Engineering," by E. B. Smith, reference was also made to the difference between the early conditions when each family was largely a self-sustaining unit, and the modern conditions where in a large factory a man may do nothing but some one minor detail in the process of manufacture. This paper dealt more particularly with the modern methods of Taylor, Emerson and others in analyzing and developing the efficiency of human energy.

Another feature of the Indiana meeting was the amount of attention given to mechanical and electrical engineering, since the State engineering societies as a rule devote their attention mainly to civil engineering. The President, Prof. L. W. Wallace, stated that the Society aimed to cover these three branches of the profession. The program included papers on locomotive design, the organization of manufacturing plants, street lighting, and loss of power in belts and pulleys of power-transmission systems. This aspect of the meeting was emphasized by a joint session of the Indiana Engineering Association and the Indianapolis-Lafayette sections of the American Society of Mechanical Engineers and American Institute of Electrical Engineers.

Distinctly civil engineering matters in fact were quite in the minority in the proceedings. They included a paper by J. S. Spiker (Vincennes, Ind.) on the works of the Brevoort levee and drainage district (described in *Engineering News* of Jan. 11). There were a few papers also on structural, paving and sewerage matters. Another group of subjects related to appraisal and the regulation of public-utilities. One evening was devoted to a general inspection of the engineering laboratories and shops, which were in full operation by the students. In this way the visitors obtained a good idea of the work and activities of the engineering department of the University.

Muscle Shoals, Tenn., as the Site for the Government Nitrate Plant

A delegation of prominent engineers of Tennessee, on behalf of the Engineering Association of the South, gave to President Wilson on Jan. 22 an engineer's brief to demonstrate that Muscle Shoals, on the Tennessee River, is by far the most advantageous site for the construction of the $20,000,000 nitrate plant provided for at the last session of Congress.

This engineer's brief is a far more convincing document than the usual lawyer's brief. It is a pamphlet of some 60 pages, gotten up in the most artistic style known to the printing art, replete with illustrations in color which are artistic gems, and containing also an abundance of maps and diagrams to reinforce the arguments in the text.

The engineers estimate the water power which may be developed at Muscle Shoals as 250,000 hp. and this may be doubled by providing storage reservoirs on the river above. These estimates all for 24-hour all-the-year-round power. For commercial power, working 10 hours per day, and available all the year except the dry-weather period, the power can be enormously increased.

The Muscle Shoals site is so far inland that it is well inside the safety zone established by the War College. A map of the United States showing available water-power sites in the United States inside the safety zone indicates that at no other site in the zone can so large a water power be developed.

In close proximity to the site are great deposits of limestone, coking coal and phosphate rock, furnishing the raw materials for the manufacture of either nitric acid in time of war or fertilizers in time of peace. The climate, labor supply, transportation facilities, and central location with reference to fertilizer markets are all in favor of the Muscle Shoals site. Its development, moreover, will complete the improvement of the Tennessee River for navigation and the products of the plant can be distributed by water over the entire area covered by the Mississippi and its navigable tributaries.

The Committee of the Engineering Association of the South, which has prepared this remarkable brief, has as its Chairman, John Howe Peyton; Vice-Chairman, Hunter McDonald, and Executive Secretary, Willis G. Waldo. The members of this committee who have given freely of their time and energy in the preparation of this unusual document have done so not merely because they were seeking to secure the location of a great industrial plant in their own locality, but in the belief that the Muscle Shoals site is so far superior to any other possible site for the Government nitrate plant that they are performing a patriotic duty in impressing its advantages on the Government officials responsible.

Flood-Control Works Projected for Los Angeles County, California

The citizens of Los Angeles County, California, are to vote on Feb. 2 on a bond issue of $4,600,000 for the construction of flood-control works according to plans prepared by J. W. Reagan, Engineer of the Los Angeles County Flood-Control District. In *Engineering News*, Feb. 10 and Feb. 17, 1916, were published full descriptions of the flood-control problem in Los Angeles County, prepared from the report of a special commission of engineers that was appointed immediately after the disastrous floods of February, 1914.

This commission recommended works for flood control having a total estimated cost of $16,500,000. Modified plans for flood control, involving about a quarter as great an expenditure, were later prepared by J. W. Reagan and after various amendments were finally adopted by the Board of Supervisors of the county on Jan. 2.

The plan of flood control recommended by Mr. Reagan follows along the general lines laid down by the board of engineers for flood control. It makes a larger use, however, of storage dams and adopts a comparatively inexpensive type of construction for the retaining walls to regulate the river channels. Check dams are to be built in mountain cañons and in addition the following storage dams: On Pacoima Wash, a concrete dam 145 ft. high to impound 3200 acre-feet of water; at the Devil's Gate site on the Arroyo Seco, a concrete masonry dam 130 ft. high to impound 6600 acre-feet of water; two miles above the mouth of San Dimas Cañon, a dam 145 ft. high to impound 2500 acre-feet of water; on the headwaters of San José creek, two earth dams 40 ft. high to store 2250 acre-feet of water. Concerning the plan for protecting the river channels, Mr. Reagan says in his report:

> The type of bank protection in general will consist of either a boulder levee thrown up by steam shovel or a single

row or double row of fencing filled in between with orchard cuttings or brush and weighted down with rock.

On the Los Angeles, Rio Hondo and San Gabriel Rivers we shall build training works consisting of a double row of piling about 5 ft. apart, on the stream face of which will be placed wire fencing and the space between the piling filled with brush and rock.

To protect Los Angeles and Long Beach harbors from inflow of silt, a dike is to be built extending southeast from Dominguez Hill to deflect flood waters to the Los Angeles River at Cerritos trestle. From this trestle to the Pacific Ocean, levees will be built due south to confine the waters to a straight channel, with a slope of nearly 8 ft. per mi. This part of the protection works will absorb nearly one-fourth of the proposed total outlay.

Grade-Crossing Removal at Detroit

A special bureau for grade-crossing elimination is to be organized at Detroit, in the city engineer's office, as a result of an investigation made by the Detroit Bureau of Governmental Research and recommendations of Mayor Marks in a message to the City Council on Jan. 9. The investigations for the Bureau of Governmental Research were made by H. S. Morse, Engineer of the Bureau.

Forty-four of the grade crossings that formerly existed in Detroit have been eliminated, but there still remain 178 grade crossings to be removed. These crossings have been classified by the city engineer as follows: Very dangerous, 4; dangerous, 121; moderately dangerous, 43; well protected, 10. At 25 of these crossings street-car lines cross the steam-railway tracks. Agreements have been reached for removing 17 of these crossings.

Heretofore responsibility for initiating and forwarding the work of grade-crossing removal has been divided among various departments of the city government, the state railroad commission and the railroad companies. The new bureau will be organized by assigning an assistant engineer from the city engineer's office, who will be in charge of the bureau; and the services of a consulting engineer will also be at his disposal to assist in carrying out the work. Under the plan previously adopted for removal of grade crossings the entire construction cost is borne by the railway company, and the city bears the cost of damages to abutting property. A rough estimate indicates that the cost of eliminating the grade crossings still in use will be about $14,000,000 for construction alone, not including damages to abutting property.

Engineering Contractors Meet

At the annual meeting of the American Society of Engineering Contractors in New York City on the night of Jan. 19, the following officers were elected: President, John T. Harrop; vice-presidents, John B. Goldsborough and Oliver O. Lefebvre; directors, A. S. Kelley, Warren Wood and William H. Hyde.

Stress was laid by H. L. Cole on the necessity for careful reading of specifications and contracts. He was of the opinion that a contractor should be paid $5 for every day the contract was finished ahead of schedule, and believed that a clause to that effect should be inserted in the specifications.

It was suggested that the monthly meetings of the society be called "Smokers"—a name calculated to increase the attendance. Meetings will be held on the second Thursday of each month. The banquet was held on the following night at the Marlborough Hotel. The first after-dinner entertainer was Edward Wegmann, who reminisced of engineers and contractors he had known in his forty years' practice. Motion pictures were then shown of the construction of the Keokuk dam.

The Milton River-Regulating Reservoir on the Mahoning River a short distance west of Youngstown, Ohio, filled nearly to the top recently. In the wet weather of the last few weeks the dam filled to within 8 ft. of the spillway crest. The city officials of Youngstown were not desirous of letting the reservoir fill to the overflow point, but it was necessary to open all four of the discharge gates wide to hold the water down.

New Pension Rules for Retired Employees of the Pennsylvania R.R. went into effect on Jan. 1. The pension allowance paid monthly by the railroad hitherto has been 1% of the average regular monthly pay during the 10 years preceding retirement, multiplied by the number of years of the pensioner's service with the company. Under the new plan, employees who during the last 10 years of their service have been unable to make full time on account of illness or infirmity will not have their pensions reduced by reason of the reduction in the average monthly rate caused by such loss of time. There is also established a minimum pension rate of $15 per month. This revised rule will apply to all employees hereafter pensioned and to employees hitherto pensioned, whose pensions will be increased by the adoption of this rule. The pension list on the Pennsylvania Lines east of Pittsburgh and Erie now contains 3,673 names. The Pennsylvania pension bureau was established on Jan. 1, 1900; since that time 7,508 employees have been pensioned, and the amount paid out has been $10,439,000.

PERSONALS

S. D. Bacon has been appointed Division Engineer of the Texas & Pacific Ry. with office at Marshall, Tex., to succeed H. P. Mobberly, resigned.

Arthur J. Rhodes, formerly Assistant City Engineer of Manhattan, Kan., has been appointed City Engineer, succeeding the late Fred Walters.

F. von Sprecken, Assistant Engineer of the Atlantic Coast Line R.R. at Savannah, Ga., has been promoted to be Division Engineer at Waycross, Ga.

Thomas C. Desmond, Assoc. M. Am. Soc. C. E., has been elected President of T. C. Desmond & Co. (Inc.), Engineers and Contractors, New York City.

R. C. Nagle has resigned as Designing Engineer for Albert Kahn, Architect, Detroit, Mich., to go to Japan for the Trussed Concrete Steel Co., of Youngstown, Ohio.

Edward T. Jeffery has resigned as Chairman of the Board of Directors of the Denver & Rio Grande R.R. after having been associated with this railway since 1891.

Albert T. Canfield has resigned as Building Engineer of the Kansas City Stock Yards Co., Kansas City, Mo., to go with the engineering department of the Union Pacific R.R. at Omaha, Neb.

John E. Williams, County Surveyor of Pottawatomie County, Kansas, has been appointed County Engineer of Shawnee County, with headquarters at Topeka, Kan., succeeding Walter Arnold.

Joseph E. Kuhn, Brigadier-General, U. S. A., who was recently promoted from the rank of Colonel in the Corps of Engineers, has been made President of the War College and Assistant to the Chief of Staff.

Malcolm Parlin has been appointed County Engineer of Leavenworth County, Kansas, with office at Leavenworth. He is a graduate of the University of Kansas and was recently Assistant City Engineer of Leavenworth.

F. S. Nicholson, for the past eight years Vice-President and General Manager of the Sayre Electric Co., Sayre, Penn., has been elected Vice-President and General Manager of the Rutland (Vt.) Railway, Light and Power Co., succeeding Byron T. Burt, resigned.

J. W. Stewart, of Foley, Welch & Stewart, railway contractors, of Vancouver, B. C., is now in charge of railway con-

struction for the Allies on the western front in France. He is a Colonel in command of several Canadian battalions which have been organized into a railway construction corps for service in France.

Eliot Wadsworth has retired from the firm of Stone & Webster, Boston, Mass., to become Acting Chairman of the Central Committee of the American Red Cross, with headquarters at Washington, D. C. He is a graduate of Harvard University and has been active in the management of the Stone & Webster properties since 1898.

Carl M. Hansen, M. Am. Soc. M. E., former Secretary and Chief Engineer of the Workmen's Compensation Service Bureau, New York City, now Managing Director of the Pennsylvania Mutual Liability Association, Philadelphia, Penn., has been made Chairman of the Committee for Accident Prevention and Workmen's Compensation of the National Association of Manufacturers.

Frederick R. Harris, M. Am. Soc. C. E., Civil Engineer, U. S. N., and Chief of the Bureau of Yards and Docks, has been named by the President as Rear-Admiral, under the new law which provides for five staff officers of the navy with the rank of Rear-Admiral. His list rank was Lieutenant-Commander, but he has had an ex-officio rank of Rear-Admiral by virtue of his position as Chief of Bureau.

David W. Taylor, Chief Naval Constructor, U. S. N., and Chief of the Bureau of Construction and Repairs, has been named by the President and confirmed by the Senate as Rear-Admiral, under the new law which provides for five staff officers of the navy with the rank of Rear-Admiral. His list rank was Captain, but he had had an ex-officio rank of Rear-Admiral by virtue of his position as Chief of Bureau.

V. H. Kreigshaber, M. Am. Soc. C. E., of Atlanta, Ga., has been appointed a member of Plaza Terminal Commission of the city, recently created by city ordinance on the suggestion of Barclay, Parsons & Klapp, Consulting Engineers, New York City. Another member of the commission is **P. H. Norcross,** M. Am. Soc. C. E., of the Solomon-Norcross Co., Consulting Engineers, Atlanta. The terminal plans recommended by Barclay, Parsons & Klapp were described in "Engineering News," Oct. 12, 1916.

Edward C. Sherman, M. Am. Soc. C. E., Consulting Engineer, Boston, Mass., has been appointed Designing Engineer in the Bureau of Yards and Docks of the Navy Department, at Washington, D. C., as a result of the nonassembled civil service examination held last December (noted in "Engineering News," Nov. 23, 1916, p. 1010). Mr. Sherman is a graduate of the Massachusetts Institute of Technology, class of 1898, and for a number of years was with the Metropolitan Water and Sewerage Board at Boston and with the Isthmian Canal Commission in Panama Canal Zone as Designing Engineer. Previous to taking up private practice he was Division Engineer of the Charles River Basin Commission, which built the Charles River dam at Boston.

Howard C. Phillips, M. Am. Soc. C. E., recently Assistant General Secretary of the Presidents' Conference Committee on Federal Valuation of the Railroads, has been appointed Secretary, succeeding Thomas W. Hulme, who has been made Vice-Chairman of the committee. He is a civil engineering graduate of Princeton University and in 1893 was Assistant Engineer on the four-tracking of the Shore Line of the New York, New Haven & Hartford R.R. Later he was on track elevation work in Boston. In 1898 he went to New Mexico on location surveys for the Pecos Valley & Northeastern R.R. He soon joined the engineering corps of the Atchison, Topeka & Santa Fe Ry. and was promoted through various grades to be Chief Engineer of the company's Coast Lines at Los Angeles in 1906. In 1912 he was made Valuation Engineer with headquarters at Chicago.

OBITUARY

William H. Hedges, one of the old-time Chicago surveyors, died at his home in that city on Jan. 16. After the great fire of 1871, when public records of land and surveys were destroyed, he gave the city free use of his own records for the public benefit.

Clarence M. Wood, County Engineer of Coffey County, Kansas, and City Engineer of Burlington, Kan., was shot and killed by an insane domestic at his home in Burlington, Jan. 14. He was graduated from Baker University in 1908 and studied civil engineering at the University of Kansas. He was formerly with M. A. Earl & Co., Muskogee, Okla.

George A. H. Mould, Assoc. M. Am. Soc. C. E., a civil engineer employed recently as Chief Estimator for C. T. Wills, Inc., General Contractors, New York City, died Jan. 21 at his home in Brooklyn. He was born in Kingston, Jamaica, and his engineering experience included supervision of construction work in Egypt, South Africa and Cuba. For many years he was in charge of erection jobs for Milliken Brothers, New York. He was an associate member of the Institution of Civil Engineers of Great Britain.

Andrew Chase Cunningham, M. Am. Soc. C. E., Corps of Civil Engineers, U. S. N., committed suicide at his home in Washington, D. C., Jan. 13. He was born in New York City, Feb. 15, 1858. He was graduated from the United States Naval Academy at Annapolis in 1878. He resigned from the service in 1884. At the beginning of the Spanish-American War he was appointed Ensign for temporary service and was honorably discharged in 1898. He was appointed Civil Engineer in the Navy about the same time.

ENGINEERING SOCIETIES

NORTH DAKOTA SOCIETY OF ENGINEERS.
Jan. 30-31. Annual meeting in Bismarck. Secy., E. F. Chandler, University, N. D.

OHIO ENGINEERING SOCIETY.
Jan. 31-Feb. 2. Annual meeting. Ohio State University, Columbus, Ohio. Secy., John Laylin, Norwalk, Ohio.

OREGON SOCIETY OF ENGINEERS.
Feb. 5. Annual meeting in Portland. Secy., Orrin E. Stanley, P. O. Box 973, Portland, Ore.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 6-7. Annual meeting in New York City. Secy., F. K. Irvine, 537 South Dearborn St., Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 7-9. Midwinter convention in New York City. Secy., F. J. Hutchinson, 33 West 39th St., New York City.

MINNESOTA SURVEYORS' AND ENGINEERS' SOCIETY.
Feb. 7-9. Annual meeting in Minneapolis.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

AMERICAN ASSOCIATION OF ENGINEERS.
Feb. 8-10. In Chicago at the Hotel La Salle.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 14-15. Annual meeting in Indianapolis. Secy., W. F. King, Indianapolis, Ind.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 19-22. Meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb 20-21. Annual meeting in New Haven in Mason Laboratory. Secy., J. F. Jackson, New Haven.

IOWA STATE DRAINAGE ASSOCIATION.
Feb. 20-21. Meeting in Fort Dodge. Secy., M. F. P. Costelloe, Ames.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting in Ames. Secy., J. H. Dunlap, Iowa City.

The Binghamton Engineering Society held its annual meeting and dinner on Jan. 23. The secretary is Ray W. Aldrich.

The Iowa State Drainage Association will meet in Fort Dodge, Feb. 20 and 21. The secretary is M. F. P. Costelloe, Ames.

The Engineers' Club of Memphis, Tenn., on Jan. 10 elected the following officers: President, A. L. Dabney; vice-president, C. C. Pashby; secretary, T. H. Allen.

The Civil Engineers' Society of St. Paul, Minn., on Jan. 8 elected the following officers: President, P. E. Stevens; vice-president, C. E. Nagel; secretary, H. A. Gerst.

The Franklin Institute on Jan. 17 elected the following officers: President, Walton Clark; vice-president, Coleman Sellers, Jr.; treasurer, Cyrus Borgner; secretary, R. B. Owens, Philadelphia.

The Connecticut Society of Civil Engineers will hold its annual meeting Feb. 20 and 21 at the Mason Laboratory, Yale University, New Haven, Conn. The secretary is J. Frederick Jackson, New Haven.

The Springfield Engineers' Club on Jan. 15 installed the following officers: President, B. H. Peck; vice-presidents, B. O. Campbell and F. R. Atwood; treasurer, C. A. Crytser; secretary, J. R. Hughes, Springfield, Ill.

The Engineers' Club of Trenton has elected the following officers for 1917: President, Fred C. Carstarphen; vice-presidents, Henry B. Kummel and Charles R. Fairchild; treasurer, John E. Elliott; secretary, Joseph E. English.

The Cleveland Association of the American Society of Civil Engineers has elected the following officers: President, Wilbur J. Watson; vice-president, Harry Fuller, of the King Bridge Co.; secretary, George H. Tinker, bridge engineer of the Nickel Plate R.R.

The Providence Engineering Society announces section meetings in the following fields: Machine shop, chemical, efficiency and scientific management, power, municipal highway and water-supply, structural, industrial and technical education, designing and drafting. A meeting will be held each week.

The Florida Engineering Society, recently organized, has planned to hold its first annual meeting in Tampa, Feb. 2 and 3, with headquarters at the Hillsboro Hotel. The chairman of the local committee is R. D. Martin, city engineer of Tampa. The secretary of the Engineering Society is J. R. Benton, Gainesville.

The American Institute of Consulting Engineers at its annual meeting on Jan. 15 in the Engineers' Club, New York City, elected to the Council the following members: Gardner S. Williams, to serve to January, 1919; A. M. Hunt, Lewis B. Stillwell and William J. Wilgus, to serve until January, 1920. The secretary is F. A. Molitor.

The Kansas Engineering Society held its ninth annual meeting Jan. 16 and 17 in Topeka, electing H. B. Walker, president, and C. M. Buck, vice-president. The secretary is C. A. Forter, Topeka. Among the several topics discussed were the Society and its relations to electrical, mechanical and railroad engineers and to architects.

The Bridge Builders' and Structural Society at the annual meeting in New York on Jan. 12 elected the following officers: President, C. D. Marshall, of McClintic-Marshall Co., Pittsburgh; vice-president, Thomas Earle, of the Bethlehem Steel Bridge Corporation, South Bethlehem; treasurer, Harry Fuller, of the King Bridge Co.; secretary, George E. Gifford, 50 Church St., New York City.

The Engineers' Society of Western Pennsylvania at its annual meeting Jan. 16, in Pittsburgh, announced the election of the following officers: President, Alex. L. Hoerr, chief engineer, National Tube Co., McKeesport, Penn.; vice-president, George H. Neilson; treasurer, Albert E. Frost; secretary, Elmer K. Hiles, Pittsburgh. On Jan. 20 the Society held a smoker at the Fort Pitt Hotel.

American Concrete Institute—At the annual meeting at the Hotel La Salle, Chicago, Feb. 8 to 10, 1917, the main papers will be "Slag and Cinders as Aggregate," by Sanford E. Thompson; "Flow of Concrete," by the United States Office of Public Roads; "Effect of Hydrated Lime on Strength, Absorption and Expansion of Concrete," by Prof. H. H. Scofield; "A Course of Instruction in Reinforced Concrete," by Prof. W. K. Hatt, and "Effect of Width of Slab on Effective Width of Design," United States Office of Public Roads. There will be in addition the usual committee reports, prominent among which this year will be one on Standard Building Regulations for the Use of Reinforced Concrete. There is expected to be considerable discussion of this because of various provisions, particularly in the flat-slab floor section, which differ from similar ones in the recent report of the Joint Committee. An innovation of the convention will be two luncheons and round-table talks.

Western Society of Engineers—The 47th annual meeting and dinner was held at the Sherman Hotel, Chicago, on Jan. 10. The addresses included "The Engineering School and the Engineering Profession," by F. E. Turneaure, dean of the College of Engineering, University of Wisconsin, and a talk on the work of the engineer in Europe after the war, by James Keeley, editor of the "Chicago Herald." The announcement was made of the award of the Chanute Prize for the following papers: "The Currents of Lake Michigan and Their Effects on the Climate of Adjoining States," by Col. C. McD. Townsend, United States Engineers (St. Louis, Mo.); "Wind Stresses in the Steel Frames of Office Buildings," Wilbur M. Wilson, Assistant Professor of Structural Engineering, University of Illinois. On Jan. 11 there was an excursion by special train to the works of the Pullman Co. and the Illinois Steel Co. The Society now has over 1200 members. The officers elected for 1917 are as follows: President, H. J. Burt; vice-presidents, D. W. Roper, J. N. Hatch and W. W. DeBerard; treasurer, C. R. Dart. The secretary is E. N. Layfield, Chicago.

Appliances and Materials

Special Trailer Truck

A special form of trailer truck is being built by the Electric Wheel Co., of Quincy, Ill., for use in connection with the small tractors or motor trucks employed in warehouses, railway freight terminals, docks, factories, etc. The trailers are so made, with diagonal connections between the axles, that the rear wheels follow the path of the front wheels in rounding curves, and all trucks in a train will follow the path of the tractor. They will traverse curves as sharp as 6-ft. radius. The frame is of steel, with wood platform 3½x7 ft., and is mounted on four 18-in. wheels with a wheelbase of 5½ ft. The wheels may be of steel (with 3-in. flat tires or rubber tires), or they may be of wood or fiber construction if desired. A swinging coupling enables trucks to be coupled at any angle. The truck has a capacity of 2½ tons and weighs about 800 lb. with steel wheels.

* * *

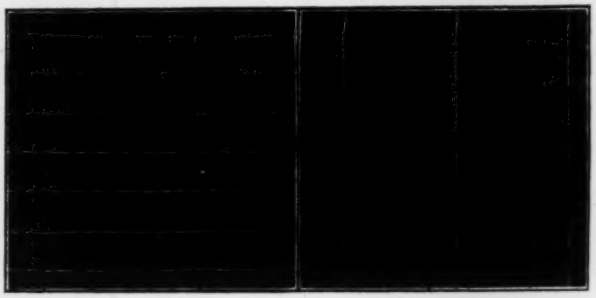
Small Alternating-Current Rectifiers

A new line of small-sized commercial rectifiers for converting alternating current to uni-directional, to be used in storage-battery charging, has been developed by the General Electric Co., of Schenectady. The rectifying element is a vacuum bulb with a tungsten filament and a graphite electrode surrounded by an inert gas—an electrical "valve" developed in this company's research laboratories. The efficiency of the rectifiers is from 30 to 75%, rising with the load. A steel casing incloses a panel or base carrying the bulb, a fuse to protect against reversal or overload, and a compensating transformer to reduce the voltage of the alternating current and to feed the bulb filament. The smallest outfit weighs 8 lb. and furnishes 2 amp. at 7 volts from a 115-volt 60-cycle circuit. The medium-sized rectifier furnishes 6 amp. at 7.5 to 15 volts and weighs 15 lb. The largest unit is for 6 amp. at 7.5 to 75 volts, having 15 taps from the compensator running to a dial switch for quick and easy adjustment of voltage.

* * *

New Metal Lathing

An entirely new lathing and light reinforcing material is now being put out by the Clinton Wire Cloth Co., of Clinton, Mass., under the trade name "welded sheathing." As shown in the accompanying view, it consists of steel wires running in opposite directions, separated for the most part by a sheet of tarred felt, but welded at intersections through small holes punched out of the felt. The longitudinal wires are No. 13 gage galvanized, spaced 3 in. apart, and are on the front or exposed side of the felt and carry the plaster or mortar. The vertical, or stay, wires are 8 in. apart, are of the same gage and are stapled to the building studs. As the plaster or mortar is applied, the felt bulges away from the horizontal wires and gives the material a chance to key all around them. The felt serves as a backing to retain the mortar and prevent waste. The material is furnished from stock in flat sheets 32 in. wide and 8 ft. long, crated in 50-sheet bundles.



CLINTON WIRE CLOTH "WELDED SHEATHING"

The cost is claimed to be about half that for all-metal lathing for the same area and service.

The material has been approved by the building bureaus of the several New York City boroughs. Two plaster partitions, one with steel and one with wood studs, were officially tested at the Columbia station and withstood a 1700° fire for one hour, followed by water from a fire hose.

This sheathing has been used for reinforcing, short light-load spans being stapled to joints and serving as the bottom form.